Identification of children's threat-related interpretation bias following trauma and the evaluation of a cognitive bias training intervention

by

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TABLE OF CONTENTS

Summary

A bias to negatively interpret information is common to many childhood mental health problems including posttraumatic stress. A typical example is when an individual automatically interprets ambiguity in a negative and/or threatening way. Understanding these biases is fundamental to cognitive treatment interventions. However, it is unclear to what extent children from non-clinical populations exhibit this interpretation bias style following exposure to a stressful or traumatic event, whether its presence increases the risk of children developing psychological problems, and whether brief interpretive bias training is effective in trauma exposed children. My PhD examined these three issues. Study 1 was conducted given current self-report measures of beliefs broadly assess trauma-related cognition but do not specifically capture dysfunctional interpretation biases. A measure was designed to index children's negative threat-related interpretive bias style (the Test of Interpretive Bias; TIB). Children (N= 178) aged 9 to 14 years were recruited from schools and completed interpretive bias and outcome measures of trauma and mood symptoms on three occasions: at baseline, and 2- and 12-weeks after the two-week assessment. As predicted, interpretive biases were associated with outcome measures indexing posttraumatic stress, general anxiety and depressive symptoms (*r*s from .38 – .46). Negative threat-related interpretive biases accounted for a small but significant proportion of trauma-related symptoms (approximately 8%) although the TIB measure was not able to accurately predict individuals at risk of later psychopathology.

As highlighted in the thesis, threat-related interpretation biases have been linked to posttraumatic stress. Study 2 examined the efficacy of a brief bias training intervention delivered in a school setting. Cognitive Bias Modification of Interpretations (CBM-I) is a training procedure previously used to alter negative interpretations and symptoms in children, typically with a focus on social or general anxiety symptoms. I assessed the effectiveness of CBM-I to facilitate an adaptive interpretation style in an unselected sample of children previously exposed to a stressful and/or traumatic event. Potential moderators (e.g., age and gender) and intervention effects were examined over time. Children (N=396) aged 9 to 14 years were randomly allocated to the CBM-I benign or neutral control conditions and completed interpretation bias and outcome symptom measures on four occasions (baseline, 2 weeks post-intervention, and again at 12- and 24-week follow up). Four training sessions were conducted during the two-week intervention. Negative threat-related interpretation biases were correlated with trauma, maladaptive cognition and mood symptoms. CBM-I modified social interpretation biases in the intervention group relative to controls. Treatment effects were observed on children's anxiety symptoms but not on the trauma-related and depression outcome measures. Excluding two exceptions, age and gender did not moderate intervention outcome. Whole sample analyses showed age moderated training effects on anxiety. Younger children regardless of group, reported a decline in anxiety symptoms, whereas older children who received the CBM-I performed better than same aged controls. Further, gender moderated children's social interpretation bias outcomes for children above the clinical threshold; specifically, girls in the CBM-I group showed a greater reduction of negative bias in response to ambiguous social situations than control girls, whereas boys in both groups showed reductions at comparable rates. Contrary to predictions, CBM-I did not safeguard children at risk of later psychopathology. That is, children showing elevated interpretative bias at baseline but not yet elevated symptoms who received benign CBM-I training demonstrated comparable rates of developing elevated symptoms at follow-up as controls. A short-term effect of CBM-I was documented in that improved state mood was observed immediately following training in the benign CBM-I group whereas no such effect was seen in controls.

Studies 1 and 2 were conducted with nonclinical samples. Following trauma exposure some children may experience posttraumatic stress disorder (PTSD). Negative and threat-related appraisals/interpretations of the trauma event and aftermath are implicated in the onset and maintenance of PTSD. Cognitive Bias Modification of Interpretations (CBM-I) has yet to be tested in children with clinical levels of PTSD following recent trauma exposure. Study 3, a pilot study, examined the effectiveness of CBM-I to influence children's cognitive biases and trauma symptoms following accidental injury. Participants (N=17) aged 8-13 years were randomised to a CBM-I positive training or waitlist condition. They completed measures of biases, trauma and mood symptoms on three occasions; baseline, 2 weeks post intervention and at 6-week follow-up. Three online CBM-I training sessions were completed at home over one week. Only six CBM-I participants and one control participant completed the study fully. Single case analyses showed three of the six CBM-I participants showed improvement in their level of negative interpretation bias. Three intervention participants reported improvement in trauma-related symptoms by follow-up. Improvement was also observed for one of the three participants with elevated anxiety at follow-up. Floor effects on some measures and substantial attrition precluded firm conclusions of the efficacy of the intervention. The thesis concludes with a discussion of the wider implications of this program of research.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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CHAPTER 1

Introduction

Over the course of their development children may encounter various stressful and potentially traumatic events (e.g., accidental injury, assault, death of a loved one) (Fairbank & Fairbank, 2009). From a psychological perspective, most children recover naturally following traumatic exposure, although a significant minority will develop Posttraumatic Stress Disorder (PTSD) (Alisic et al., 2014; Le Brocque, Hendrikz, & Kenardy, 2010). PTSD is characterised by a cluster of persistent symptoms (e.g., re-experiencing, hypervigilance, avoidance, cognitive and emotional disturbance) that elicit a sense of current threat which interferes with adaptive processing of the trauma and healing (Ehlers & Clark, 2000). Rates of PTSD in children vary due to sampling and assessment methods but range between 0.5 -16% (Alisic et al., 2014; Copeland, Keeler, Angold, & Costello, 2007). In part, what distinguishes between those children who recover naturally following trauma exposure, and those who do not, can be explained by what are broadly defined as ‘cognitive models of PTSD’ (Ehlers & Clark, 2000; Meiser-Stedman, 2002). These will be elaborated upon in a later section, but first I will outline the rationale for my program of research.

Effective, evidence-based PTSD interventions for children exist (Cohen, Mannarino, Berliner, & Deblinger, 2000; Smith et al., 2013), with the majority of trauma-focused therapies having a large emphasis on targeting maladaptive cognitions (Meiser-Stedman et al., 2017; Nixon, Sterk, & Pearce, 2012; Smith et al., 2013). However, not all children benefit from such interventions, and it is increasingly recognised that access to high quality mental health support, including for PTSD, may be difficult due to limited specialist resources (e.g., suitably trained therapists), family finances, long waiting lists, and geographical barriers (Anderson, Howarth, Vainre, Jones, & Humphrey, 2017; Cohen, Berliner, & Mannarino, 2000; Cohen & Mannarino, 2008; Kenardy, Cox, & Brown, 2015; Lal & Adair, 2014; Stallard, 2006). There is therefore a need to test brief and accessible interventions that can be easily administered for children with posttraumatic stress, with online or computer-based formats having the potential to address this need. Although cognitive bias modification (CBM) methods suit this purpose, with respect to child PTSD, measurement tools for indexing negative interpretive biases are somewhat lacking. Appropriate assessment of such biases is a necessary prerequisite before testing the effectiveness of interventions designed to modify these biases. Existing questionnaires assessing childhood anxiety and trauma cognition do tap into the construct of negative interpretation bias but do so broadly and sometimes somewhat indirectly. Accordingly, my thesis begins by first testing a measure of interpretative bias that includes items specific to types of cognition proposed by PTSD theorists to be associated with the development and maintenance of PTSD (e.g., a sense of ongoing threat, exaggerated vulnerability). Next, over two studies, my thesis examines whether maladaptive trauma-related cognition, an underlying mechanism of childhood PTSD, can be modified with Cognitive Bias Modification-Interpretation (CBM-I), a computer-based training model designed to promote cognitive change (MacLeod & Mathews, 2012). Thus, the overall goal of the project is to test whether this intervention works in the context of childhood PTSD, with the hope it might lead to the dissemination of a simple and accessible treatment for children following trauma.

There is good reason to think CBM-I methods have utility in assisting children with PTSD. Cognitive biases characterise most clinical disorders including PTSD (Ehlers, Mayou, & Bryant, 2003; Muris & Field, 2013). Negative appraisals, which can include interpretation type biases, are implicated in the development and maintenance of childhood anxiety generally, and are defined as when an individual, in the absence of confirmatory evidence, automatically perceives ambiguous situations or events as negative and/or threatening (Beck, Emery, & Greenberg, 2005; Mathews & MacLeod, 2002; Muris & Field, 2008; Stuijfzand, Creswell, Field, Pearcey, & Dodd, 2017). Early CBM-I research showed that individuals with and without an interpretive bias orientation can be systematically trained over repeated trials to adopt a certain interpretation style (i.e., negative or positive) when processing ambiguity (Grey & Mathews, 2000; Mathews & Mackintosh, 2000). Meta-analyses of CBM with adult samples that followed these seminal investigations have reported medium to large effects of this training on target biases (Effect size (ES) ranging from 0.52 to 0.81), and a reduction of anxiety symptoms following CBM-I (Jones & Sharpe, 2017). This proof of principle intervention has since expanded to investigations with nonclinical and clinical childhood populations but predominately in the context of general or social anxiety (Lester, Field, & Muris, 2011a; Muris, Huijding, Mayer, & Hameetman, 2008; Muris, Huijding, Mayer, Remmerswaal, & Vreden, 2009; Vassilopoulos, Banerjee, & Prantzalou, 2009). Similarly, reviews of child CBM-I studies suggest the intervention has demonstrated capacity to alter maladaptive interpretive biases in children, and in some instances, attenuate anxiety (Cristea, Mogoașe, David, & Cuijpers, 2015; Krebs et al., 2017).

To date CBM-I effects are unknown in the context of child posttraumatic stress. My research will assess the efficacy of the training model together with a basic examination of the reliability and validity of some of the measures that might be used to detect bias change following such interventions. In doing so I will advance our theoretical understanding of the underlying cognitive mechanisms of childhood PTSD by examining the presence and stability of threat-related negative interpretive biases as well as testing the efficacy of the CBM-I approach to modify children's dysfunctional trauma-related cognitions and symptoms following trauma exposure. My testing of CBM-I in children with posttraumatic stress will also have important clinical implications. Foremost, specifically whether this intervention may benefit a paediatric population. The remainder of the chapter will outline the theoretical underpinnings of the child anxiety - negative interpretation bias relationship, with a specific focus on the cognitive model of PTSD and how threat-related appraisals/interpretations contribute to and maintain child trauma symptomology. I also examine the origins of the CBM-I model and relevant child/youth literature. In sum, I will (a) provide a brief overview of anxiety theory and outline Ehlers and Clark's (2000) cognitive model of PTSD, (b) describe dysfunctional appraisals associated with childhood PTSD, (c) outline the CBM-I process, and (d) review CBM-I research with unselected and clinical child samples as well as CBM-I adult trauma studies.

Cognitive models of child anxiety

Cognitive models (sometimes referred to as information processing models) have been dominant explanations for psychopathology, including anxiety and trauma-related difficulties, for a number of years. For example, more than 30 years ago Kendall (1985) suggested that negative cognitive biases, associated with childhood anxiety, occurred due to an overactive threat schema used to guide processing in response to perceived or actual threat (see also Muris & Field, 2008; Stuijfzand et al., 2017). It was theorised that this danger and/or vulnerability schema orients an individual's preoccupation for threatening and/or negative information. According to information processing theory (Crick & Dodge, 1994), a disruption at the subsequent interpretation stage may lead to a rapid and distorted appraisal because additional information is not encoded (Daleiden & Vasey, 1997). Consequently, an individual with this selective processing bias may interpret ambiguous information in an adverse way (MacLeod, 2005) and develop a negative interpretation style that which maintains the problem (Daleiden & Vasey, 1997).

Evidence of children's general processing biases and threat perception abnormalities being associated with anxiety have been widely demonstrated by narrative reviews (e.g., Mathews & MacLeod, 2002; Muris & Field, 2008) and supported by recent meta-analyses (Stuijfzand et al., 2017). These findings support the view that negative interpretation biases play a central role for the onset and maintenance of childhood anxiety, although much of this research remains cross-sectional. Although it is beyond the scope of this thesis to provide a detailed analysis of the general anxiety literature, the following findings are representative of this body of research and are relevant to my thesis. Accordingly we know that when processing ambiguity, relative to children with low anxiety, children with higher levels of anxiety typically require less information to assess a situation as dangerous and/or threatening (Castillo & Leandro, 2010), report a high frequency of threat interpretations (Muris, Kindt, et al., 2000), and are more likely to catastrophise when appraising mildly stressful situations (Vassilopoulos & Banerjee, 2008). Moreover, a recent study examining the mechanisms of therapeutic change for children with anxiety found reductions in negative interpretation biases was a significant mediator of symptom change (see also Creswell & O'Connor, 2011; and Muris & Field, 2008 for similar findings ; Pereira et al., 2017). Findings such as these reinforce proposals by authors (e.g., MacLeod, 2005) that selective processing of threat-related interpretations could represent a means to identify individuals at most risk of developing psychological problems and be a potential index of clinical change. Further, the relationship between anxiety and negative interpretation biases may be best summed by Stuijfzand et al's (2017) comprehensive meta-analyses from 75 studies involving children and adolescents. Findings suggest a moderate size of effect (d = .62) showing a medium positive association between negative interpretation and anxiety symptoms with age (i.e., strength of association increased with age) and content specificity (i.e., matching of content with anxiety subtype) moderator effects.

Information processing biases in PTSD

Although much of the research on negative interpretation biases has involved children with anxiety, a small number of adult based studies have examined bias processing information with traumatised individuals. Using a sentence completion task Kimble et al., (2002) investigated the semantic interpretation biases of combat veterans with and without PTSD. Consistent with information processing theory, when processing ambiguity individuals with PTSD, when compared with traumatised individuals not experiencing PTSD, were more likely to complete the sentences with threatening endings. Later research by Kimble, Batterink, Marks, Ross and Fleming (2012) with a community sample found when presented with a choice of word endings (i.e., words that made sense, were grammatically correct but did not make sense, or threatening) individuals with PTSD compared to their counterparts, typically indicated threatening words when completing an ambiguous sentence task. Similarly, traumatised individuals have been found to respond faster to ambiguous than non-ambiguous information and show a rapid inhibition for trauma-related information (i.e., process more threat words than neutral words) (Amir, Coles & Foa, 2002). Taken together these adult population studies provided further understanding interpretation biases associated with PTSD and the possible influence these biases may have for traumatised children.

Although overlap exists between characteristics and symptoms of other anxiety disorders and PTSD (e.g., intrusive cognition, bias processing and avoidance coping; APA, 2013), selective processing bias for threat is particularly relevant to understanding the phenomenon of PTSD, given emphasis placed by theorists on the role maladaptive appraisals and unhelpful trauma-related beliefs in its development. Although Ehlers and Clark's (2000) cognitive model of PTSD was first developed to explain symptoms in traumatised adults, its application to childhood PTSD has received empirical support (Meiser-Stedman, 2002; Stallard, 2003) and will now be discussed.

The cognitive model of PTSD

Maladaptive appraisals and trauma-related beliefs are a key component of Ehlers and Clark's (2000) cognitive model. PTSD symptoms persist in part because these appraisals influence dysfunctional coping behaviours (e.g., avoidance of trauma reminders, social withdrawal) and unhelpful cognitive strategies (e.g., thought suppression, rumination and dissociation). These coping responses maintain a sense of threat and/or negative self-image because they interfere with the processing and integration of the trauma memory needed for adaptive adjustment, as well as preventing accurate or more adaptive cognitive appraisals (Ehlers et al., 2003; Ehlers & Steil, 1995; Halligan, Michael, Clark, & Ehlers, 2003; Hiller et al., 2018). For example, if an individual interprets an intrusive trauma memory as dangerous or mentally harmful, this is likely to trigger emotional distress and physiological reactions which motivate unhelpful suppression and/or avoidance strategies, preventing the individual from learning that the distress is likely short-lived and that the intrusion does not lead to significant harm. Further, Meiser-Stedman's (2002) review of Ehlers and Clark's theoretical account of PTSD suggests the key variables identified in the adult-focused model have relevance for the conceptualisation of PTSD in children. Similarly, other research with children following accidental injury demonstrates the applicability of the model to correctly identify the presence of PTSD in this population (Stallard, 2003).

Studies have also shown trauma-related appraisal biases can take various forms (see Bryant, Salmon, Sinclair, & Davidson, 2007; Leeson & Nixon, 2011; Meiser-Stedman, Dalgleish, Glucksman, Yule, & Smith, 2009). For example, appraisals can be externally focused such as exaggerated fears and vulnerability (e.g., *The world is dangerous, something bad will happen again*), or internally focussed and concern inflated responsibility (i.e., *It was my fault*), negative self-image (e.g., *I am weak and unable to cope*) and/or perceptions of permanent change (e.g., *I am damaged forever*) (Dunmore, Clark, & Ehlers, 1999; Ehlers & Clark, 2000). Investigations have also observed developmental differences in children's appraisals following trauma exposure (Bryant et al., 2007; Meiser-Stedman, Dalgleish, et al., 2009). Adolescents for example, tend to report biases that concern disturbing and permanent change of the self-image (e.g., *My life has been destroyed by the frightening event*) (Meiser-Stedman, Yule, Smith, Glucksman, & Dalgleish, 2005), whereas negative appraisals for younger children are characterised by vulnerability and inability to cope (e.g., *Anyone could hurt me*) (Bryant et al., 2007; Meiser-Stedman, Dalgleish, et al., 2009).

The association of appraisal biases on PTSD have been examined in several child/youth trauma cognition studies, both cross-sectionally (Meiser-Stedman, Dalgleish, Smith, Yule, & Glucksman, 2007; Salmon, Sinclair, & Bryant, 2007; Stallard & Smith, 2007) and longitudinally (Bryant et al., 2007; Ehlers et al., 2003; Meiser-Stedman, Dalgleish, et al., 2009). The findings from these studies suggest that maladaptive appraisals are strongly related to posttraumatic stress symptomatology (r = 0.74) (Meiser-Stedman, Dalgleish, et al., 2009) and after controlling for initial stress reactions, account for a significant proportion of the variance (e.g., 33-49%) of later PTSD symptoms (Bryant et al., 2007; Ehlers et al., 2003). Moreover, a recent review of information processing in adults suggests individuals with PTSD, compared to those without PTSD, are more likely to over–estimate subjective risk and interpret ambiguous information as threatening (Bomyea, Johnson, & Lang, 2017). Taken together, that is, the cognitive framework by PTSD theorists (e.g., Dalgleish, 2004; Ehlers & Clark, 2000; Meiser-Stedman, 2002) and the empirical literature just summarised, it is clear that unhelpful trauma-related appraisals play a significant role in PTSD symptom development and in turn, in efforts to promote positive adjustment for those seeking treatment. As previously cited, effective treatments for childhood PTSD exist (e.g., Trauma-Focused CBT) although these require effortful cognitive restructuring by children (as well as by the therapists that teach these skills), and as highlighted, these interventions are accompanied by access difficulties and treatment non-response. These limitations therefore create opportunities for alternative interventions designed to promote cognitive change. CBM-I, a relatively brief intervention, and one that arguably requires less effort on the part of children and therapists (compared with traditional, individual face-to-face therapy), holds some promise as either an adjunctive or standalone therapy for child PTSD. A review of the CBM-I training method now follows.

Cognitive Bias Modification of Interpretations

Cognitive bias modification (CBM or CBM-I) is a computerised training process designed to promote a desired pattern of cognitive change (MacLeod, Koster, & Fox, 2009). This concept was first tested by Grey and Mathews (2000) with an adult population. Over a series of experiments the researchers demonstrated that a specific interpretation bias (i.e., negative or positive) could be acquired following the completion of repeated trials. For example, participants trained to interpret positive meanings of homographs reported more benign interpretations of ambiguous words compared with those in the negatively trained condition. The idea a cognitive bias could be experimentally induced was further tested using CBM-I trials involving a scenario format. Mathews and Mackintosh (2000) used ambiguous social scenarios that were resolved by the completion of word fragments (e.g., *Your partner asks you to go to an anniversary dinner that their company is holding; you have not met any of their work colleagues before. Getting ready to go, you think that the new people you will meet will find you (fri….y/ Friendly or bo….g (Boring)* to modify participants' interpretation of the situation. A manipulation check, designed to test acquisition of the intended bias following the trials (i.e., *Will you be disliked by your new acquaintances? Yes/No),* indicated an interpretive bias style consistent with the assigned positive or negative training condition. In addition, the researchers also observed congruent mood changes in participants' state anxiety following the bias training.

These preliminary findings stimulated numerous CBM-I investigations with community and clinical adult populations with anxiety and depression. An initial systematic review on the effects of 45 CBM studies with adults reported a medium effect on biases (g = 0.49, CI_{95} = [0.36, 0.63][2]) but no significant effect of training on anxiety (g = 0.13) (Hallion & Ruscio, 2011). However, the effect of CBM training on interpretive biases, when examined separately from attention bias training, showed a larger effect (g = 0.81, CI_{95} [0.59, 1.03]). A more recent meta-analyses of CBM-I training for benign interpretations by Menne-Lothmann et al. (2014) observed it resulted in an increase in positive interpretation bias, relative to negative interpretations (*ES* = 1.33), and a small yet significant reduction in immediate negative mood state post training (*ES* = 0.25). Although the benign training effects were reliably different from the negative training effects, the changes were not consistently different from the neutral or no training control conditions. However, the researchers did report larger improvement in cognitive and mood effects following benign CBM-I when it was accompanied using imagery and in studies using greater number of sessions. Another meta-analysis included adults diagnosed with anxiety and mood disorders (i.e., in 32 of the 49 RCTs, participants had a subclinical or mental

[2] This review collapsed effect size data for both *attention* and *cognitive* (interpretative) bias studies.

health diagnosis) who received CBM within randomised controlled designs. However, the authors did not analyse the effects of CBM on biases but on clinically relevant outcomes (Cristea, Kok, & Cuijpers, 2015). The authors of this study examined attention and interpretation bias studies and found small but mostly non-significant effects for effect on anxiety and depression.

The reviews of CBM-I suggest the intervention has demonstrated capacity to modify negative interpretation biases (even though evidence of symptom impact is less robust), which has relevance for children who also exhibit this type of cognitive bias (Muris & Field, 2013; Muris, Luermans, Merckelbach, & Mayer, 2000). This style of processing bias is considered stable (Creswell & O'Connor, 2011; Dodd, Hudson, Morris, & Wise, 2012; Muris, Meesters, Smulders, & Mayer, 2005) and affects anxious children across different age groups (Waite, Codd, & Creswell, 2015). Typically, clinically anxious youth, compared with matched controls, interpret ambiguity in a threatening manner (Cannon & Weems, 2010; Dodd et al., 2012; Taghavi, Moradi, Neshat-Doost, Yule, & Dalgleish, 2000; Waite et al., 2015). Similarly, research with nonclinical samples has observed children with higher levels of anxiety tend to discount positive interpretations of mildly negative situations, and more likely to catastrophise (Vassilopoulos & Banerjee, 2008) and perceive threat at a faster rate, and more frequently, than their low-anxious peers (effect sizes [Hedges g] ranging from 1.03 - 1.27; Muris, Kindt, et al., 2000; Muris, Merckelbach, & Damsma, 2000). Although changes in symptoms with CBM-I have been less compelling, the development of the field with adult samples is encouraging. Further, the presence of interpretation biases for children and the natural developmental period for cognitive growth, warrant its extension to investigations with youth populations (Lau, 2013). A review of the child CBM-I literature is now presented.

CBM-I in children and youth

This section will first outline CBM-I studies with unselected children and adolescent samples, and then present research that has examined CBM-I with at risk/clinical populations, before discussing trauma-relevant CBM studies.

CBM-I with children

As with the adult studies, preliminary investigations of CBM-I with children have been conducted to assess whether an interpretive bias could be induced in the face of hypothetical situations. Set to the context of an outer space adventure, Muris and colleagues demonstrated the effects of CBM-I with an unselected sample of children aged 8-13 years (Muris et al., 2008; Muris et al., 2009). Prior to the CBM-I training, children were given a background story that they are astronauts travelling through space with their parents searching for a planet where people can live. They land on a planet that resembles earth and they begin to explore it. Children responded to ambiguous vignettes describing an unknown situation that might occur on this new planet and given directive feedback (i.e., 'Good' or 'Wrong') to foster a positive or negative interpretation bias according to the assigned condition. For example, '*On the street, you encounter a spaceman. He has a sort of toy handgun and he fires at you…*' A) '*You are laughing; it is a water pistol and the weather is fine anyway'* (positive option) or, B) *'Oops, this hurts! The pistol produces a red beam which burns your skin!'* (negative option). Evidence of successful cognitive training was demonstrated across both studies. Subsequent research using Muris et al.'s (2008) 'space odyssey' paradigm added a self-report measure of avoidance tendencies as a proxy index of children's anxiety levels (i.e., measured by the marked distance (millimetres) on a drawing where the children would situate themselves relative to scenery on the unknown planet) (Muris et al., 2009). Results suggested that following negative bias training, high anxious children reported both stronger negative interpretation bias and higher level of avoidance tendencies relative to low-anxious children.

Following the early work of Muris and colleagues, Lester at al.'s (2011a) experimental research modified interpretative biases in children (7-15 years) using real life situations (animals; encountering a new animal not previously seen and social situations; moving to a new town) and measured its effect on children's anxiety vulnerability (i.e., state mood, happiness measured by an analogue mood scale before and after the behavioural avoidance task; (BAT)) and behavioural response (i.e., a BAT used to test the child's willingness to perform task; animal touch box or speech in front of peers). After the modification training, across conditions, children's interpretation biases were consistent with the specific training objective (i.e., children learned to select the negative outcomes with ambiguous animal and social situations following negative training and the opposite was observed for the positive conditions) although bias change was not significantly correlated with participants' performance on the BAT (r_s =.02) or change in anxiety across the BAT (r_s =.08). Although Lester et al. (2011a) did not find evidence to support that interpretative bias change was associated with change in anxiety or avoidance behaviour, they did observe developmental patterns of normative fear. For example, training that induced biases towards and away from animal threat was more effective than that observed in social situations in younger children, whereas induced biases across both social and animal categories was evident for older children. In a later study these researchers manipulated threat interpretive biases of healthy children using an ambiguous situation depicting a similar novel animal (Lester, Field, & Muris, 2011b). Participants reinforced to interpret situations with a positive bias showed a *decrease* in threat biases (i.e., there was a large pre-post change in bias, d = 1.01), as well as a significant reduction in avoidance behaviour when exposed to a stress task (e.g., approaching a small cage to pat a concealed fake marsupial) compared with children who received negative bias training (with these children demonstrating a moderate pre-post *increase* in threat bias, d = 0.53).

Another research group have examined the effects of CBM-I regime to modify children's social interpretation biases and symptoms. Vassilopoulos et al. (2009) used ambiguous social scenarios to train a benign adaptive bias style in a non-clinical sample of children. Children's interpretation biases were indexed using a series of ambiguous social stories (based upon a previously developed measure; Vassilopoulos & Banerjee, 2008) where participants rated their level of agreement (i.e., whether the interpretation would come to mind) in response to the negative and benign interpretations options. An improvement in children's negative interpretation bias, a reduction in trait social anxiety symptoms, and less anxiety meeting unknown peers was observed following three sessions of benign CBM-I training (i.e., three successive sessions of 15 trials) compared with no training controls. These findings were replicated by the authors in a study that compared the effectiveness of verbal versus imagery instructions with 4 sessions (i.e., 18 trials in each) of benign CBM-I (Vassilopoulos, Blackwell, Moberly, & Karahaliou, 2012). Across both verbal and imagery conditions participants who were trained to make benign interpretations reported fewer negative interpretations and less negative consequences of ambiguous events. Further, verbal instructions were observed to be more effective and led to a greater decrease in negative interpretation biases and social anxiety. Research using similar methodology observed changes in children's interpretation bias style, decrease in negative and increase in benign interpretation pre to post training following three sessions (i.e., 16 trials each) of benign CBM-I but that this did not translate to improvement in anxiety symptoms (Vassilopoulos, Moberly, & Zisimatou, 2012).

Vassilopoulos and colleagues have since gone on to expand our understanding of the CBM-I model, investigating whether the effect of the intervention is influenced by the presentation of training mode (i.e., written or spoken presentation of the training materials (Vassilopoulos, Blackwell, Misailidi, Kyritsi, & Ayfanti, 2014), as well as whether the inclusion of a same-gender peer to discuss the ambiguous scenario outcome in place of receiving automatic corrective feedback (i.e., *correct or wrong*) shaped an adaptive interpretation bias style (Vassilopoulos & Brouzos, 2016). In addition, CBM-I effects have also been examined in children with hostile attribution and externalising behaviours (Vassilopoulos, Brouzos, &

Andreou, 2015). Respectively, these studies showed children who were trained to adopt a negative interpretation bias using a spoken presentation were more likely than children who read the training trials to negatively interpret ambiguous social situations, however the differential effect between the spoken and written conditions for the benign interpretation training was less clear (Vassilopoulos et al., 2014). Further, collaboration with a peer during CBM-I training compared with non-intervention controls resulted in less endorsement of negative interpretations, lower level of frustration with a stress task and lower social anxiety symptoms. Similarly, Vassilopoulos, Brouzos, et al. (2015) observed treatment effects on children's hostile and benign attributions and lower self-reported aggression following three sessions of CBM-I training compared with non-trained controls. As reviewed, most of the CBM-I research with children has been conducted with the child as the individual participant, however two studies, with unselected samples, have assessed the intervention with the involvement of parents/caregivers' support.

Recognising the influence of parents on a child's learning, Lau, Pettit, and Creswell (2013) drew upon parent/child interactions to shape children's (aged 7-11 years) acquisition of a benign interpretation style. Parents of children in the experimental condition were instructed to read a series of bedtime stories over three consecutive nights and, following the child's responses, provide corrective feedback and paraphrased explanation of the benign resolution to reinforce the desired positive bias. The intervention condition, but not the assessment only controls, reported a significant reduction in social anxiety symptoms (d = 0.53) over the week of testing. All participants endorsed fewer *negative* interpretations over time, but this reduction only reached significance for the intervention participants (d = 0.94). Both groups demonstrated an improvement in *benign* interpretations, although the within-group effect was significantly larger for the experimental (d = 1.78) than the control condition (d = 0.56).

Another study involved parents/caregivers in delivering CBM-I training to counter children's anxiety associated with a real-life stressor (i.e., primary to secondary school transition) (Cox, Bamford, & Lau, 2015). Participants were assigned to either parent administered CBM-I or an active control condition (i.e., identifying worrying situations and completing problem-solving workbooks). Improvement in interpretation style was observed for CBM-I participants (i.e., increase in benign and reduction in negative interpretations) relative to controls, although children across both conditions reported adaptive change in the level of anxiety overtime. This result suggests CBM-I effects can be helpful with stressful life events although reduction in anxiety may be equally achieved with exposure to worrying problems and/or as a function of positive parent-child interaction. Taken together these studies suggest CBM-I can modify problematic biases and, in some cases, the effect of positive bias training can result in a very large and clinically significant reduction of anxiety symptoms in children.

As with unselected child samples, CBM-I has been widely investigated with adolescent populations. Early investigations with adolescents examined CBM-I effects with a single experimental session, with later studies incorporating comparison control conditions and increased training exposure. However as discussed next, although the impact of CBM-I for older children shows evidence their biases can be modified too, and in some cases subjective affect following training also changes, not dissimilar to some adult findings, whether actual *symptom* reduction has occurred has been variable.

CBM-I with youth

Lothmann, Holmes, Chan and Lau's (2011) experimental study was the first to demonstrate the malleability of interpretation biases in adolescents and change in state mood (as measured by a positive/negative affect scale) that was congruent with the bias training condition. Change in mood state, although measured subjectively, is important as the experience of negative affect may operate as an emotional precursor for psychological disorders (Lonigan, Phillips, & Hooe, 2003). Lothmann et al. observed that adolescents' interpretation biases could be trained in a positive or negative direction and that positively trained participants, compared with those in the negative condition, endorsed more positive and less negative interpretations of new ambiguous situations. Further, after positive training, negative affect *decreased* across participants, whereas negative training led to a decrease in *positive* affect, although this was observed only for the male participants. A small number of successive studies have replicated these findings showing that a positive or negative interpretation bias can be systematically induced (ES ranging from moderate-to-large between groups; positive change: Cohen's *d* = 0.71 to 1.76, negative change: *d* = 1.03 to 2.11) and, in accordance with the trained bias, influence subsequent interpretations of new ambiguous situations (Lau, Belli, & Chopra, 2012; Lau, Molyneaux, Telman, & Belli, 2011; Telman, Holmes, & Lau, 2013). However, the training effect on adolescents' mood state immediately following a *single* CBM-I session has been less clear with some results showing positive bias change did not translate to a change in positive affect (Lau et al., 2011), or was shown to decrease negative affect pre to post training across both group conditions (Lau et al., 2012). In another study, bias training resulted in a decrease in positive affect for both the positive and negatively trained participants (Telman et al., 2013). Notwithstanding these findings, additional benefits of a single positive CBM-I have been observed beyond a change in bias. These include faster processing speed when solving problem solutions (positive trained vs placebo control, *d* = 0.40; Salemink & Wiers, 2011), rating life stressors as having less impact upon one's adjustment/distress (i.e., positive trained group endorsement of positive appraisal ratings vs negative trained group, *d* = 1.15; Telman et al., 2013), and lower anxious mood (positive vs negative trained, *d* = 0.81) when performing a timed monitored task (i.e., arithmetic puzzle challenge) (Lau et al., 2012).

Collectively these initial investigations provide support that adolescent biases can be induced with CBM-I and that a trained positive bias may have additional benefit. Building on this work the following studies examine the effect of positive bias training with neutral/placebo control conditions (i.e., typically a combination of positive and negative scenarios) although not all CBM-I findings are robust with several null or weak findings observed.

Salemink and Wiers' (2011) research with unselected youth compared the effects of a single session of benign and neutral CBM-I training on general anxiety (i.e., state and trait anxiety). Following training, the intervention participants reported small to moderate effects in their positive (d = 0.40) and negative (d = 0.80) interpretations of new ambiguous information relative to controls, but no change in the level of state anxiety symptoms. Another study investigating the effects of single session CBM-I with adolescents preselected for high trait anxiety (N =77, mean age 14 years) largely found no discernible effects (Fu, Du, Au, & Lau, 2015). The researchers did not directly measure participants' broader anxiety symptoms although positive and negative affect (i.e., state mood) was assessed using visual analogue scales before, during and after training. Interpretation biases were modified across all participants, but no group interaction effects on positive or negative mood emerged following training. As now discussed, other research has assessed the effect of CBM-I on broader outcomes, including mood/depressive symptoms.

Using a neutral control condition, Chan, Lau, and Reynolds' (2015) study of older adolescents (aged 16-18 years) assessed the effect of two sessions of positive CBM-I on anxiety and depression symptoms and participants' level of affect following training. Results showed both intervention and control participants reported an increase in positive and reduction in negative interpretations following the training sessions (assessed immediately post training and at one-week follow-up, for positive interpretations only) with some reduction in depressive symptoms overall but no change in trait anxiety. Further, positive affect for all participants reduced over time, whereas negative affect either remained unchanged (controls) or fluctuated (for the intervention group, this initially reduced, then slightly increased). Most studies discussed thus far have assessed the immediate effects of brief CBM-I delivered within the laboratory or in a school setting. In contrast the longitudinal research by deVoogd and colleagues investigated the short- and long-term effects of online CBM-I training on adolescents' interpretation bias, anxiety and depression symptoms and emotional resilience (de Voogd, Wiers, de Jong, Zwitser,

& Salemink, 2018). Participants completed eight online sessions over one month. Interpretation bias, as measured by a Recognition Task[3], became more positive for the intervention group, although this fell short of significance when compared with controls and both groups improved in their positive interpretations of probe scenarios (i.e., dis-ambiguous scenarios). Reduction in negative interpretation bias (i.e., improved positive interpretation bias) was not shown to increase participants' resilience and reduce anxiety and depression symptoms. Thus, assessment over an extended period (i.e., 3, 6 and 12 months) revealed a similar pattern of decline in anxiety and depression symptoms across the conditions.

As indicated in the above discussion, similar to the research reviewed earlier, studies with unselected adolescents have also reported null findings. Although these findings add to our knowledge of the field, methodological issues may provide some explanation for these results. These include inadequate measures of mood (i.e., measuring state affect rather than broader symptoms) (Fu et al., 2015; Salemink & Wiers, 2011), level of training and brevity of outcome assessment (Chan et al., 2015; Fu et al., 2015; Lau et al., 2012; Salemink & Wiers, 2011) and floor effects of negative interpretations (i.e., normative functioning of unselected/community sample) (Chan et al., 2015; Fu et al., 2015). deVoogd et al.'s (2018) longitudinal research addressed some of these concerns but other factors unique to their study may account for the lack of significant differences between the training conditions. These may include: reduced experimenter control over participants' task compliance and timing with online CBM-I training, the process of natural recovery overtime and, the positive effect of the placebo condition and/or the assumption that a neutral control comprising ½ positive and ½ negative training scenarios is an inert condition (Blackwell, Woud, & MacLeod, 2017).

[3] In this case the Recognition task involves a series of disambiguated social scenarios that are followed by a title and four statements that differ in their resemblance to the unresolved scenarios but are not an exact match. Two of the statements are positive and negative interpretations; the targets. The induction is successful if the targets are rated in accordance with the orientation of training, i.e., as more like the original ambiguous scenarios. The other two statements are not interpretations but positive and negative foils, distractor statements that assess the degree to which the training has shaped a general affective bias toward items of a particular valence (Mathews & Mackintosh, 2000).

As the primary goal of CBM-I is to alter interpretation biases to improve symptoms, the effectiveness of positive training for children at risk of or already suffering with clinical levels of anxiety or depression has been investigated. The few studies conducted to date show both positive and null findings. These studies are now discussed.

Effectiveness of CBM-I in at-risk child samples and those with clinical levels of symptoms

In terms of CBM-I efficacy for children who might be considered at risk of developing a clinical disorder, White et al. (2016) examined whether reducing threat-related interpretations was associated with a decrease in variables that might make children vulnerable for anxiety (in this case, children who were already high in behavioural inhibition). Interpretation and attention bias toward threat was assessed. Interpretation bias was measured using short scenarios describing school situations (i.e., giving a presentation, interacting with peers). Participants were presented with two ending options (e.g., one positive, the other negative) and asked to select the one they believed how the scenario would end in real life. Following a single training session, the intervention group showed significantly higher positive interpretation bias scores and lower level of negative interpretation biases post training compared with controls. The modification of bias however did not generalise to other measures of anxiety vulnerability (i.e., anxiety vulnerability to stress task–speech performance, attention bias to threat and children's immediate negative affect after training). The study did not include any follow-up, precluding examination of whether the intervention could prevent new onset of problematic anxiety.

Turning towards research with children with clinical symptoms levels, Orchard, Apetroaia, Clarke, and Creswell's (2017) three sessions of positive CBM-I for children with clinical levels of social anxiety (aged 7 to 12 years) likewise did not translate to significant increases in benign or decreases in negative interpretation bias relative to controls, although differences in change in benign bias among the CBM-I group approached significance (d = 0.52). Unexpectedly and somewhat counter-intuitively, severity of anxiety symptoms for the intervention group increased and decreased for the controls. It is unclear why this situation occurred, and the authors did speculate the anomaly might be due to a lack of bias change for this clinical population because of the low intensity of training. Although this is possible, an alternative explanation may be that the findings simply reflect a natural fluctuation of symptoms in a chronic anxiety group.

Recognising the importance of treatment dose, Klein and colleagues significantly increased the number of training sessions in their research relative to earlier CBM-I investigations. Klein et al. (2015) recruited a clinical sample of children aged 7 to 12 years who had been diagnosed with varying anxiety disorders (i.e., social, separation, generalised anxiety). Participants were randomly assigned to positive training where the scenario's final word ended in a positive way or neutral training conditions (i.e., scenarios ended in an irrelevant or factual way), and children completed 15 sessions of training in a two-week period. Children with elevated pre-existing interpretive bias showed a reduction in social threat-related biases following training compared with neutral controls. However, training did not appear to affect intervention participants' interpretation bias relating to general threat or non-threat scenarios. Further, self-report anxiety level for the intervention group was not lower than controls at post-training. Parents of the intervention children, but not parents of the control condition, did however report a significant reduction in the child's anxiety after the training. Although parents were unaware of their child's training condition, they accompanied the child at the first practice training session, therefore demand effects cannot be ruled out.

The last child study reviewed in this section was conducted with children diagnosed with Social Anxiety Disorder (SAD) and involved child/parent dyads as part of the intervention. Reuland and Teachman (2014) examined the effect of online positive CBM-I with three conditions (i.e., child only, *n* = 6; parent only, *n* = 6; and combined child/parent, *n* = 6). Although the sample size was modest, compared with the child only condition, symptoms for three of the six participants in the combined child/parent group observed an improvement in social anxiety following training.

Complementing the research with younger children reviewed above, the three studies discussed next have investigated CBM-I with *adolescents* with SAD and generalised anxiety disorder (GAD) (Fu, Du, Au, & Lau, 2013), as well as Major Depressive Disorder (MDD; LeMoult et al., 2017; Micco, Henin, & Hirshfeld-Becker, 2014).

CBM-I in youth with clinical levels of symptoms

Fu et al.'s (2013) study of adolescents (N=28, aged 12-17 years) with anxiety disorders (i.e., SAD and GAD) found no significant differences following one session of CBM-I between groups' (i.e., positive vs neutral) endorsement of positive interpretations (an intervention vs. control design was adopted). Although there was no training effect on positive biases ratings at post training (assessed by a recognition task), the intervention participants' ratings of negative interpretations on the subsequent testing scenarios were significantly less negative than controls and showed a large between group effect (d = 1.26). The CBM-I effect on anxiety symptoms was not assessed although participants' negative, but not positive state mood (as measured with a Visual Analogue Scale) reduced across both conditions pre to post training. In comparison, Micco et al. (2014) administered *four* CBM-I sessions in a clinical research setting over a 2 week period to examine the treatment effect on both depression and anxiety symptoms for adolescents who either met the criteria, or sub-threshold criteria (i.e., at least three symptoms) for MDD (N= 42). The average age of participants in this study was 17 years. Biases were assessed using an adaptation of Mathews and Mackintosh's (2000) recognition task that involved training scenarios with depressive themes (i.e., potential loss, failure and rejection). The authors found when the effect of CBM-I with the whole sample was analysed, negative interpretation biases did not differ between the two groups. However, intervention participants with higher interpretation biases at baseline, compared with controls, showed greater improvement in their interpretations at mid treatment ($p = .02$) and a trend at posttreatment ($p = .07$). Although the significant group difference in bias level had diminished by the two weeks follow up ($p = .27$), medium between-group effects were observed for participants with higher baseline negative bias at post ($d = 0.77$) and at follow up ($d = 0.66$) assessments. The researchers however did not find any significant group differences in symptoms, with all participants reporting a reduction in anxiety and depression during and after CBM-I training. A more recent study conducted by LeMoult et al. (2017) examined CBM-I with younger adolescents, also diagnosed with MDD. The authors administered six online training sessions (i.e., positive or neutral) over two weeks and tested whether a trained positive bias could generalise to measures of interpretation bias measured by: a) a scramble sentences test, where adolescents rearranged a scrambled sentence to reflect either a positive or negative statement, b) a blended word task, which required participants to listen to phonetically similar words – sad/sand- negative, joy/boy-positive, and indicate the word that was heard, and c) via an attentional bias task (i.e., dot–probe to assess attention bias for emotional or neutral facial expressions). Change in clinical symptoms was assessed by self–report measures. At post-assessment (2 weeks from baseline assessment) intervention participants endorsed significantly more positive interpretations compared with neutral controls, but there was no treatment effect on negative interpretation biases. Further, the trained positive bias did not generalise to subsequent measures of interpretation or attention bias or influence participants' depressive symptoms. The effect of the two studies with adolescent depression show a similar pattern (e.g., change in bias style but no conclusive evidence of symptom change), although, like childhood anxiety, CBM-I with childhood depression is a new area of clinical research and thus requires further study and replication before firm conclusions of its efficacy (or not) can be drawn. Another area of CBM-I with clinical children/youth in its infancy is comparative research with an established treatment intervention. To date, apart from the study by Cox et al. (2015) discussed earlier where the comparison condition involved active problem solving, to my knowledge only one research group has examined the effect of CBM-I with Cognitive

Behavioural Therapy (CBT) as the comparator condition. A review of this comprehensive study with its impressive follow up is now provided in some detail.

CBM-I compared with CBT

Sportel and colleagues' randomised control trial study compared the effect of CBM-I and group CBT on children's social and test anxiety, although it should be noted that the CBM-I condition also involved attention bias training (the results of attention bias analyses are not discussed in this review) (de Hullu, Sportel, Nauta, & de Jong, 2016; Sportel, de Hullu, de Jong, & Nauta, 2013). Participants (N = 240) were randomly assigned to either: 20 online CBM sessions at home (combined interpretation and attention bias training and other trials to strengthen associations between social-evaluative situations and positive outcomes), 10 group CBT sessions at school with homework a component, or to an assessment only control. Interpretation biases were assessed with two measures; a recognition task and an existing self-report questionnaire. Social and test anxiety symptoms were measured by established self-report scales.

The Single Target Implicit Association Test (stIAT)[4] was also used to assess automatic threat-related associations with social or school activity. Results showed the CBM condition's interpretation of ambiguous social situations with the recognition task, compared to the CBT and control group were less negative and more positive at post assessment (12 weeks from baseline). Change in interpretation biases assessed by the self-report questionnaire were less negative in the CBM group compared with controls, although positive social interpretations increased at post assessment for all conditions. In addition to the change in bias, the researchers observed that social anxiety symptoms reduced across all conditions at post assessment (12 weeks from

[4] The stIAT is computerised reaction time task that measures the extent to which a target category (e.g., social or school activity) is associated with a negative (threatening) or positive (safe) label. For a socially anxious individual the association between the negative outcome and social cue words is assumed strong therefore the pairing of negative outcomes with the target category is faster compared to slower response time association between target categories and positive outcomes (de Hullu, de Jong, Sportel, & Nauta, 2011).

baseline). CBT interventions showed a greater reduction in social anxiety symptoms relative to the reduction in symptoms for controls from post-test to six months follow up (CBT within group; *d* = 0.41). The difference between the CBM reductions of social anxiety over this period, compared with controls, was non-significant. All conditions showed a decrease in the level of test anxiety between pre-post assessment however the within-group change in test-anxiety scores for the CBT intervention was significantly larger between pre and post-test (*d* = 0.32) and from post-test to 6 months follow up (*d* = 0.58) compared to the control condition. No overall time effects for automatic threat-related association with social and school activity (stIAT) were observed across the assessment period (pre, post, 6 and 12 months follow up). At pre to post assessment the CBT showed less within-group reduction in negative automatic associations on the stIAT than the CBM (*d* = 0.36) and control (*d* = 0.28) conditions. Further, the increase in positive automatic associations was stronger for the CBM (*d* = 0.61) than for the CBT and controls from 6 to 12-month follow-up.

Interestingly, at the 12 months follow up the control group's level of social anxiety had reduced to the same levels as the training conditions (which remained at 6-month levels), with no significant differences apparent between any condition. The long-term efficacy of the interventions showed test anxiety and automatic threat-related association decreased, across conditions, over time. The overall difference between the CBT and control conditions' reduction in test anxiety was significant and showed a small effect (*d* = 0.34). There was no overall significant difference between conditions for the implicit threat-related associations, although from the pre-test to 12 months follow up interaction the CBM condition demonstrated a larger reduction in threat-related associations than the CBT condition (between-group *d* = 0.61).

A two-year follow-up of this study resulted in 121 of the 240 participants (50%) completing the follow up assessment, although the attrition was comparable across the CBT, CBM and control conditions (de Hullu et al., 2016). On the self-report questionnaire, interpretation biases significantly decreased from pre-test to the 2-year follow-up, but conditions reduced at a similar rate. In contrast, the decrease over this period on the recognition task was influenced by group, with CBM, but not the CBT condition, showing significantly larger reductions on the recognition task than controls. Further, although there was an overall decrease in social and test anxiety from pre-test to the 2 year follow up, non-significant interactions overtime between the CBT and CBM conditions indicate the interventions did not have any additional influential effect on the reduction of symptoms.

Proportionally, the number of children who had developed a social anxiety disorder was low and similar across all groups (5.9% out of 119). Similarly, participants' level of automatic threat-related associations with social anxiety and school activity remained stable over the follow-up period and was comparable across groups (de Hullu et al., 2016).

Sportel and colleagues' (de Hullu et al., 2016; 2013) longitudinal investigations provide a detailed and informative understanding of how well CBM-I compares with established treatment interventions. The study has considerable strengths, which include the sizeable treatment dose, appropriate comparison conditions, and excellent follow up periods. The study was able to examine the impact of the interventions on level of self–reported social and test anxiety. However, the number of children who met the full diagnostic criteria for social anxiety disorder (SAD) at baseline was between 11-16% across conditions (n = 31). Unfortunately, this low number of SAD diagnoses prevented the researchers from testing whether the interventions could prevent the onset of new cases of SAD. Further, as common with longitudinal research, a number of participants were lost due to attrition (e.g., n = 117; 49% of total 2013 study sample) and, on average, participants only completed 43% of CBM and 67% of CBT sessions. Furthermore, the inclusion of CBM-I (45% - 9 sessions), attribution bias modification (40% - 8 sessions ABM) and positive association training task (15% - 3 sessions) in the CBM intervention does not allow the impact of these treatment components to be analysed separately. However, the results of this important study have shown that with enough training CBM can lead to an improvement in cognitive processing and faster reductions in anxiety symptoms when compared to no treatment. Although it should be noted that while the reduction in symptoms was faster following CBT, these gains diminished overtime, with children in both CBM and no treatment control groups performing as well as each other in terms of symptoms at 1-year follow-up. That said, compared with CBT and no training controls, positive automatic threat associations continued to improve for CBM participants' overtime. This supports the efficacy of CBM and suggests that a relatively small amount of CBM treatment may have enduring positive effect on children's automatic processing of threat and is relevant when considering CBM-I for children experiencing posttraumatic stress (PTS).

The critique of the CBM-I investigations discussed thus far show research in this period has primarily targeted childhood anxiety related disorders, with no child study to date focused upon trauma-related symptoms. A search of the literature revealed only three studies that have examined CBM effects in adult analogue trauma designs (Woud et al., 2018; Woud, Holmes, Postma, Dalgleish, & Mackintosh, 2012; Woud, Postma, Holmes, & Mackintosh, 2013). These are now examined.

CBM-I and adult analogue trauma studies

Woud and colleagues trained healthy adults to either adopt a positive [functional] or negative [dysfunctional] appraisal in response to viewing distressing films. The researchers tested whether bias training might improve PTS-like outcomes if the training was received before (Woud et al., 2013) or after (Woud et al., 2012) analogue trauma exposure. Individuals who received the positive training following the film reported a significant reduction in trauma appraisals relative to the negative training at post training. These gains were shown to further improve at one-week follow-up for those positively trained (post to follow up, $d = 0.56$ [within-group ES], relative to pre-post change, $d = 0.26$). Further, the positively trained group experienced fewer intrusions and less distress from the intrusions than those negatively trained. Similarly, training received *prior* to the film (Woud et al., 2013) led to a significant improvement (lower scores) in trauma symptoms at one-week follow-up for the positive group, relative to the negative group, (between-group *d* = 0.30). These findings were also observed in a more recent investigation by the research group, whereby positive training, compared to negative training, led to an increase of *adaptive* appraisals following analogue trauma exposure (Woud et al., 2018). These studies using analogue trauma designs with adult samples demonstrate the potential utility of the CBM model for use with trauma affected populations.

Summary

In sum, following trauma exposure, children who experience posttraumatic stress disorder (PTSD) do so in part because they develop a threat-related and/or negative processing bias. Evidence based therapies exist to correct unhelpful trauma-related processing but are not always accessible nor universally lead to good end state functioning. As such there is a growing need to explore alternative and/or supplementary cognitive interventions that may assist traumatised children and reduce the burden of psychological injury. Although distinct disorders, children with PTSD exhibit dysfunctional processing biases like children with anxiety problems, with these biases seen at higher levels than in non-anxious peers. Negative and/or threatening interpretations of an ambiguous situation is a typical example of the context in which these biases appear for children. Empirical research over the past decade and more has shown negative interpretation biases associated with anxiety can be altered with Cognitive Bias Modification of Interpretations (i.e., systematic training to interpret ambiguity in an adaptive way). Although CBM-I research has demonstrated that positive and/or negative biases can be induced in children and adolescents, as indicated by the review, studies have used different methodologies that have often produced different effects of CBM-I and mixed results. As detailed in the review, some of these discrepant results may be attributable to sample or interpretation target (e.g., focus on mood rather than broader symptoms/anxiety) and methodological considerations (training dose, type of control condition).

Despite discrepancies in the field, collectively the literature review has shown CBM-I training can orient children toward an adaptive interpretation bias style, with some evidence this can translate also to symptom change. Further, as highlighted earlier, there is a paucity of CBM-I studies of trauma samples. Work to date has been conducted by the same research group, focussed on adults, within an analogue trauma design. That said, the findings hold promise that CBM approaches might facilitate an adaptive appraisal style leading to symptom reduction following analogue trauma exposure. These findings, combined with CBM-I work in child anxiety samples, support the exploration of this approach with children experiencing trauma-related symptoms. Towards this goal, given current assessment tools designed to index trauma-related cognitions do not specifically target negative threat-related biases associated with ambiguity, there is a need to develop such measures.

Accordingly, this thesis will involve three studies to extend our knowledge in these areas. The first study involves the development of a measure to index children's negative threat-related interpretation biases (Chapter 2). The initial reliability and validity of the measure is assessed in children from an unselected community sample with several goals: (a) to determine if children from the normal population exhibit threat-related interpretation biases following stressful and/or traumatic events, (b) to examine whether threat-related interpretation biases are stable, (c) to evaluate whether negative threat-related interpretation biases can account for variance in trauma symptoms and, finally, (d) determine if the measure can predict whether children who currently have a high level of negative threat-related interpretation bias are at greater risk of developing future problems.

Study 2 investigates the effectiveness of a brief positive CBM-I training protocol (4 sessions) with an unselected sample with the aim to modify children's threat-related interpretation biases and reduce posttraumatic stress symptoms (Chapter 3). The influence of potential moderators is also examined in order to understand for whom the intervention may most benefit. The longitudinal design of the study allows for the examination of long-term effects of the CBM-I training and whether the intervention has any preventative benefit for children at risk of later psychopathology. Finally, the third study assesses the effectiveness of positive/benign CBM-I for children with significant post-traumatic stress disorder symptoms following accidental injury (Chapter 4). Accordingly, this small pilot study extends the work of studies 1 and 2 to determine the potential value of CBM-I in a clinical sample. Further, the literature refers to the terms, maladaptive appraisal bias (i.e., a term specific to trauma theory, literature and assessment) and interpretation bias (i.e., commonly used in anxiety studies) to describe processing biases associated with perceived threat. I have retained these specific terms when discussing the relevant PTSD and anxiety literature and used *threat-related interpretation bias* to collectively describe these terms throughout this body of work.

CHAPTER 2

Study 1

Children can be exposed to a broad range of traumatic events (e.g., abuse, accidental injury, interpersonal, community violence, natural disaster), with 20% to 86% exposed to events capable of resulting in posttraumatic stress disorder (PTSD) (Fairbank & Fairbank, 2009). These estimated rates are wide-ranging and influenced by methodological factors (e.g., nation studied, sample characteristics) yet highlight that children's exposure to traumatic events is relatively common (Fairbank & Fairbank, 2009). For those children exposed to trauma, estimates of child PTSD range between 0.5 -16% (Alisic et al., 2014; Copeland et al., 2007), again influenced by sample and method of assessments. Children can also exhibit distressing posttraumatic stress-like symptoms (e.g., intrusive thoughts, distress at reminders) in response to events that do not constitute a Diagnostic and Statistical Manual of Mental Disorders, (5th ed.; *DSM-5;* American Psychiatric Association [APA], 2013) Criteria A stressor (e.g., parental divorce, moving house, loss of a friendship) (Copeland, Keeler, Angold, & Costello, 2010).

The psychopathology that occurs following trauma exposure has a detrimental impact upon children, affecting their functioning across various domains (e.g., development, social, health) (Cohen, Mannarino, & Deblinger, 2016). As shown by the discrepancy between rates of trauma exposure and actual PTSD prevalence, many children exposed to traumatic events recover without treatment, however a not insignificant proportion of individuals remain symptomatic. One factor implicated in the development of PTSD, and which is the focus of the present study, is negative trauma-related appraisal bias. The terms appraisal (i.e., act of assessing or evaluating something) and interpretation (i.e., the action of explaining the meaning of something) (VandenBos, 2015) are similar in meaning and have been used to describe bias cognition associated with PTSD and anxiety disorders respectively (and sometimes interchangeably). Negative appraisal or threat-related interpretation bias is evident when an individual perceives a neutral or ambiguous situation as negative or potentially threatening

(Mathews & MacLeod, 2002) and has been linked to poor mental health outcomes (Mathews & MacLeod, 2005). Irrespective of which term is used across research areas, a subjective negative bias interpretation of an experience is argued to be a central feature of childhood anxiety and posttraumatic stress disorders (Ehlers et al., 2003; Meiser-Stedman, 2002; Muris & Field, 2013). Research with child trauma samples has shown negative cognition is associated with exaggerated perception of vulnerability and risk of harm, as well as maladaptive coping (Bryant et al., 2007; Leeson & Nixon, 2011). These findings lend support for the theoretical model proposed by Ehlers and Clark (2000) which emphasises the critical role of dysfunctional appraisals in the onset and maintenance of PTSD. Specifically, appraisal biases that occur following trauma exposure perpetuate a dysfunctional pattern of cognition and impede recovery because they elicit a sense of current threat that leads to avoidance coping (i.e., external/internal avoidance of trauma-related stimuli; places, conversation, thought, feelings), which in turn prevents distorted beliefs from being challenged or re-appraised. Similarly, other theoretical research has also highlighted the role of maladaptive cognition and unhelpful beliefs in the development and maintenance of PTSD (Brewin, 2001; Foa, Huppert, & Cahill, 2006). Originally used to explain the cognitive mechanisms of PTSD in adults, these cognitive theories have shown their applicability in explaining childhood PTSD (McKinnon, Nixon, & Brewer, 2008; Meiser-Stedman, 2002; Stallard, 2003). As will soon be discussed, the cognitive model of PTSD underscores the importance of the current research, especially the need to identify cognitions such as negative interpretation biases that may increase the vulnerability of trauma symptoms but have not been clearly studied to date in children following stressful and or traumatic events. First, it is important to review the interpretation bias literature that has been researched among children and adolescents, although this has generally been in the context of general anxiety, rather than with reference to specific negative or traumatic events.

Evidence from non-clinical investigations of biases show a positive correlation between children’s anxiety symptoms (i.e., trait, social) and threat interpretations (ranging from .24 to

.51) (Hadwin, Frost, French, & Richards, 1997; Muris, Kindt, et al., 2000; Muris, Luermans, et al., 2000; Muris, Merckelbach, et al., 2000; Vassilopoulos & Banerjee, 2008). Results from such investigations indicate sizeable biases for threatening information are typically demonstrated by children with high anxiety symptoms (Hadwin et al., 1997; Muris, Luermans, et al., 2000; Muris, Merckelbach, et al., 2000; Vassilopoulos & Banerjee, 2008). For example, children with higher levels of anxiety display lower thresholds for threat perception and more frequently perceive threat than low-anxious children, with effect sizes [Hedges' *g*] for these differences ranging from 1.03 -1.27 (Muris, Kindt, et al., 2000; Muris, Merckelbach, et al., 2000). Furthermore, children with heightened anxiety are more likely to discount positive interpretations and express catastrophic interpretations to mildly negative events (Vassilopoulos & Banerjee, 2008). These findings suggest anxious children from unselected samples are inclined to exhibit a threat-related processing bias. Accordingly, as interpretation biases is thought to be a maintenance factor in anxiety disorders, this propensity may increase the child's later risk. Further evidence in support of this position can be found within clinical investigations.

Not surprisingly clinical population studies have found clinically anxious children and adolescents, compared with matched controls, report significantly higher level of threat interpretation when processing threat-related, neutral and/or ambiguous material (*g*'s ranging from 0.57 – 1.13) (Cannon & Weems, 2010; Dodd et al., 2012; Taghavi et al., 2000; Waite et al., 2015). Although the studies' methodologies varied, the collective findings lend support for the proposal that schema-based information processing perspective bias interpretation is a central characteristic of anxiety symptoms and its related disorders (Beck, 1985). However, although there is a general agreement threat interpretive biases are a feature of childhood anxiety for both unselected and clinical samples, the predictive relationship between interpretive bias and anxiety is less clear.

A small number of prospective studies on anxiety have examined the predictive role and stability of threat-related interpretative biases. For example, Muris and colleagues reported children's level of threat perception biases and anxiety symptoms predicted later symptoms when examined over brief intervals, that is, 4- (Muris, Jacques, & Mayer, 2004) and 8-weeks (Muris et al., 2005) respectively. In both studies, threat perception abnormalities were not predictive of anxiety symptoms or vice versa (i.e., bias only predicted bias and anxiety only predicted anxiety). Creswell and O'Connor's (2011) examination of children's threat interpretations over a 12-month period suggested that biases appear to be a relatively stable characteristic. The study also reported a significant and moderate positive correlation (at Time 2, 5months r =.46 to Time 3, 11months r =.58) between children's threat interpretations and anxiety symptoms with regression analyses demonstrating a unidirectional link (i.e., anxiety predicted change in threat interpretation). Findings from prospective investigations with clinical samples however have varied.

Results from Dodd et al.'s (2012) study with young children (e.g., assessment beginning age 3-4 years) showed at baseline clinically anxious children were more likely than children without an anxiety diagnosis to interpret ambiguous story stems as threatening. When baseline anxiety was controlled, threat interpretation biases significantly predicted parent-reported child anxiety symptoms at 12 months follow up but not at later assessment (i.e., 2 and 5 year follow up). The results suggest interpretive biases, at least in the short-term, may play some role in maintaining anxiety. Conversely, threat interpretive biases for clinically anxious youth were not predictive of anxiety diagnostic status, beyond that predicted by children's perception of control (i.e., control over external threats and anxiety symptoms) (Cannon & Weems, 2010). In sum, although some support for the predictive role of interpretation bias with anxiety has been found, threat-related interpretative biases in anxious children relative to their non-anxious peers is less well established. As now discussed, the predictive role and stability of negative interpretation biases in the context of specific negative events and childhood PTSD is less well understood.

The proposal that errors in cognitive processing are linked with poor mental health outcomes is not new (see, for example, Crick and Dodge, 1994, and Dodge, 1991). Building from this work, as previously noted, PTSD in children and adults is conceptualised by the presence and influence of unhelpful maladaptive beliefs and appraisals (Ehlers & Clark, 2000; Meiser-Stedman, 2002). With respect to cognition, it is argued that unhelpful cognition can include global-type statements (e.g., *No one can be trusted*), as well as negative interpretations of ambiguous or benign situations, for example, interpreting someone approaching on a street as intending harm whereas in the absence of further information, a just as likely interpretation might be the person will ask for help. Negative interpretations can even be seen in one's own symptoms (e.g., interpreting intrusive memories as signs of going crazy).

While a number of studies have examined the role of unhelpful trauma-related beliefs in predicting the persistence of PTSD in children (Bryant et al., 2007; Ehlers et al., 2003; Leeson & Nixon, 2011; Meiser-Stedman, Dalgleish, et al., 2009; Nixon, Nehmy, et al., 2010; Salmon et al., 2007) the majority of these studies have used self-report measures that indexed both global beliefs or general negative interpretations (e.g., of one's symptoms). Although these studies demonstrate that beliefs and interpretations measured in this fashion strongly predict persistence of PTSD (with typically accounting for 26-44% of the variance in later symptoms over a range of follow-up periods), they do not speak to what is happening with interpretive bias as has been measured in other non-PTSD research (i.e., methods that index bias for threat or of ambiguous situations).

In addition to a lack of research on interpretive bias following stressful or traumatic events in children, there is a relative paucity of measures to index this, with most derived from other psychopathology domains. A search of the literature has shown existing questionnaires measuring children's cognitive bias have focused upon interpretive biases and attributions relating to: depression (e.g., Children's Attributional Scale Questionnaire—Revised; Kaslow & Nolen-Hoeksema (as cited in Thompson, Kaslow, Weiss, & Nolen-Hoeksema, 1998), Negative Cognitive Errors in Children Questionnaire; Leitenberg, Yost, & Carroll-Wilson (1986)) and social anxiety (e.g., Negative Social Events Catastrophizing Questionnaire; the Positive Social

Events Discounting Questionnaire; Vassilopoulos & Banerjee (2008); Ambiguous Situations Test- AST, Vassilopoulos et al., (2009)), with a number of these measures tapping into children's attributional or trait style (e.g., internal-external, stable-unstable, global-specific). As mentioned earlier, although there are trauma-specific measures of unhelpful cognitions (e.g., Children's Posttraumatic Cognitions Inventory, cPTCI; Meiser-Stedman, Smith, et al., (2009), these contain items that index broad unhelpful beliefs as well as items that could be viewed as appraisals or interpretations, but not necessarily of ambiguous situations per se. Alternatively even though an interpretive bias measure has recently been tested in adults with PTSD (Boffa III, 2015), it requires a higher level of abstract concept and literacy skills than is developmentally appropriate for children.

In sum, interpretative bias has been well researched in both non-clinical and clinical samples with the focus on anxiety and not depression in many of these studies. PTSD research has shown threat-related appraisals following exposure to a traumatic event are implicated in the development and maintenance of childhood PTSD. However, existing measures of children's threat-related cognition following traumatic exposure broadly assess children's maladaptive stress reactions, beliefs and appraisals. For example, the cPTCI measure asks about explicit negative statements around trauma and trauma related symptoms but does not index threat-related interpretive bias associated with ambiguity nor does it assess *how* children interpret trauma related information. No study to date has investigated whether threat-related interpretative biases exist for unselected children who have experienced stressful and/or traumatic events. That said, the current study is not only interested in the unselected sample as a whole, but also those individuals at elevated risk of psychopathology, and the subset of children already above the clinical cut-offs of relevant measures. The testing of a questionnaire designed to measure children's interpretation bias will provide valuable information about how children interpret ambiguity and their everyday experiences and could lead to a means to identify children who may be at risk of poor mental health outcomes before displaying significant symptoms.

Further, although I expect this measure of bias (the Test of Interpretive Bias; TIB) to be correlated to trauma related cognition, I also predict that it will make a separate and unique contribution to the development and maintenance of PTSD. The focus of the present study is timely given the increasing research on bias modification programs in both children and adults (Lau et al., 2012; Vassilopoulos, Moberly, & Lau, 2015).

I had several aims and predictions. First, in a large, unselected sample (cross-sectional design), I examined how a measure of bias (the Test of Interpretative Bias; TIB) related to posttraumatic stress (PTS), general anxiety and depression symptoms. I predicted bias would correlate with these measures but anticipated stronger relationships with PTS and general anxiety. I was also able to test how well the TIB discriminated between a subset of children with elevated symptoms and their low-symptom peers. I predicted children with a high level of bias, as measured on the TIB, would be more likely than children with lower level of biases to report maladaptive symptoms. Second, a subset of the initial sample was assessed at three-time points (baseline, T1; two-weeks later, T2; and 12-weeks following baseline, T3). I was thus able to document the stability of interpretative bias and test the prediction that interpretative bias would predict PTS over time. I predicted the level of interpretive bias would remain stable overtime and account for a significant proportion of variance on trauma and other outcome measures. I was also able to document whether high baseline levels of interpretative bias were associated with increased risk of new onset of problems in the clinical domains under study (i.e., PTS, anxiety, and depression). Finally, I predicted the proportion of children who reported later problems would be significantly greater for children with a high level, compared to those with low-level of baseline interpretation bias.

Method

Creation of the Test of Interpretation Bias

The Test of Interpretive Bias scale (TIB) developed for the present study, was used to index children's negative interpretive bias relating to perceived threat. As indicated by earlier review, a search of key literature portals (i.e., EBSCO, PsychInfo, PsychArticles, and Google Scholar) produced few assessment options to measure threat-related interpretation biases pertinent to PTSD. Given the confines of time and resources within a PhD, it was beyond the scope of my thesis to undertake full development of the measure, that is, to follow the typical conventions around test construction procedures (e.g., Clark & Watson, 1995). Nonetheless, the creation of the TIB enabled preliminary elements of the measure to be examined (e.g., internal reliability, test-retest reliability, convergent validity). Item selection for the TIB was influenced by Ehlers and Clark's (2000) cognitive model of PTSD and the format of the scale modelled upon the research of Vassilopoulos and colleagues (2008; 2009) and Kaslow and Nolen-Hoeksema, (as cited in Thompson et al., 1998).

The TIB items encompassed the domains of threat perceived by PTSD sufferers as identified by factor analysis of children's trauma beliefs, described in the construction of Meiser-Stedman, Smith et al.'s (2009) measure of maladaptive trauma-related cognition, the Child Posttraumatic Cognitions Inventory (cPTCI; see the Measures section for a full description). Thus, a pool of items was developed to index themes related to children's sense of vulnerability, perception of danger, hypervigilance, self-blame, not fitting in, negative self-view and mistrust. The items were reviewed by a researcher and psychologist with expertise in the area of child trauma research, as well as a teacher, who assessed items in relation to relevance to posttrauma reactions and developmental appropriateness. The items were also pilot tested with two children for readability and comprehension. For ethical reasons the TIB items did not embed the themes in explicit trauma-type situations, rather interpretation items were set in the context of ambiguous scenarios children typically encounter in day to day life (e.g., peer interactions, school-based activities, general experiences). Further, as suggested by the cognitive model, when encountering trauma reminders, or ambiguous stimuli that may have been previously associated with the event, traumatised individuals may negatively process the situation and experience a sense of current threat (Ehlers & Clark, 2000). Thus, my objective for the TIB items was to present an ambiguous situation that might capture threat-related interpretations as indicated by the cPTCI's two components (e.g., Disturbing and permanent change; feeble person in a scary world) for children with trauma symptoms. For example, the following TIB items were designed to tap into a) not having normal feeling since the event: 'People have different feelings, sometimes you can feel happy, sad and then angry. Having feelings that change mean you are…normal / crazy', and b) mistrust; 'An item was stolen from your school bag. This means you should… not trust anyone/don't leave valuable in your bag'. Each TIB scenario was followed by a benign and a negative threat-related interpretation to which children made a response. Some examples include: 'Something unexpected happened as you walked into the classroom. You think, *I should always be ready [threat interpretation]/ it is unlikely to happen again [benign interpretation]'* and, 'You have been asked to do something new and notice some reactions within your body. You have felt this before and recognise it as feelings of, *fear [threat] / excitement [benign]'.* The threat interpretation of these two example items are designed to measure hypervigilance and negative association with arousal which are characteristic of posttraumatic stress.

Different formats for responding were trialled across the cross-sectional and longitudinal studies (see Appendices A to F for TIB format styles and further psychometric details). In Sample 1, 146 children (range 7 to 14 years of age) were administered one of two parallel forms of the TIB (i.e., A & B). Each form presented 12 ambiguous situations for which the child was asked to imagine the situation happening to them and to select a preferred response. For example, 'You are playing on online game with others kids. Your character is losing. This is because a) *Of something out of my control* or b) *I'm a bad player*. A separate negative and benign/positive bias score was created by totalling the number of responses selected for each category. After initiation of the study, on reflection it was considered the dichotomous scoring approach would be improved with a Likert-type scale, thus a smaller number of children (n = 42; range 13 to15 years of age) completed a modified measure. The children were presented with the same scenarios and interpretation options however for each interpretation (negative and benign) they indicated how much they agreed or disagreed with interpretation on a 4-point scale ranging from 0 (‘*Disagree a lot’*) *to* 3 (*‘Agree a lot’*). The negative and benign interpretative responses were presented in fixed random order. A total positive and negative interpretive bias scale score was obtained with higher scores reflected stronger interpretative bias in the desired direction. In Sample 2 (n = 395; range 9 to 13 years of age), the Likert-type scale was used, however Form A and Form B was administered as a single, longer (i.e., 24-item) measure. Given these different variants, after examining (separately) the internal consistencies, correlations with symptom measures, it was decided to create a z score for each version so that the samples could be pooled (see Appendix G for details and analyses). Accordingly, the final analyses use a Z-score for two scales - the negative and positive interpretative bias scales, where higher scores reflect stronger bias.

Participants

An unselected sample of 583 children aged 7-15 years was recruited from public and private [South Australian] primary and high schools from metropolitan (5) and regional (7) areas of the state (See Table 1 for participant characteristics). Primary school children (n = 537) involved students from years 4 to 7 and accounted for 92% of the total sample. The recruited schools were located in areas that encompassed a range of socioeconomic bands as measured by the Index of Community Socio-Educational Advantage (ICSEA:Australian Curriculum Assessment and Reporting Authority, 2014), a standardised index (higher scores reflect higher advantage) (see Appendix H for the combined sample ICSEA z-score). Participating schools ranged from low to high disadvantage (see Table 1). Data was pooled from two unpublished studies; Sample 1 comprised 188 children who also participated in follow-ups (this subset represented the longitudinal aspect of the current paper). Participant's from sample 1 represented 23% of the 819 children, invited across five schools, which agreed to participate. Sample 2 (n =395) was recruited as part of a recently completed trial of interpretative bias training and was used to maximise sample size (only baseline data from that trial was used in the present paper) (see Appendix I for the two samples' ICSEA z-scores). Of those invited to participate in sample 2 (i.e., 918 students across six primary schools) 43% eventually did so. Exclusion criteria included children who were identified by caregivers and/or teachers as likely to have difficulty with measures due to developmental delay, literacy or language issues, as well as children under the care of child protection services given challenges with obtaining consent. Thus, twenty-five children were excluded on these factors. The university and relevant school ethics committees approved the study.

Table 1

Demographic Characteristics

Variable	Sample 1 (N=188) *M* (*SD*)	Sample 2 (N=395) *M* (*SD*)	Total (N=583) *M* (*SD*)
Age	11.16 (1.76)	10.93 (.935)	11.01 (1.21)
Range in years	7-15	9 -13	7-15
Male sex	50% (*n* = 94)	47% (*n* =187)	48% (*n* = 281)
Ethnicity			
White	93% (*n* =175)	92% (*n* = 364)	92.5% (*n* = 539)
Other	6% (*n* =12)	7 % (*n* = 29)	7% (*n* = 41)
Missing	1% (*n* = 1)	.5% (*n* = 2)	.5% (*n* =3)
School			
Primary	75.5% (*n* = 142)	100% (*n* = 395)	92% (*n* = 537)
Secondary	24.5% (*n* = 46)		8% (*n* = 46)
School region			
Metropolitan	55% (*n* = 103)	45% (*n* = 179)	48% (*n* = 282)
Regional	45% (*n* = 85)	55% (*n* = 216)	52% (n = 301)
School type			
Public	78% (*n* = 147)	55% (*n* = 218)	63% (*n* = 365)
Private	22 % (*n* = 41)	45% (*n* = 177)	37% (*n* = 218)
School Index Range	923-1075 (n = 6)	893-1136 (n = 6)	893-1136 (n = 12)

Note: School Index with a *M* of 1000 and *SD* 100 (higher scores reflect higher advantage) See Appendix U for full descriptive statistics for each of the key study measures discussed below.

Measures

A 21-item self-report measure assessed children's PTS reactions following exposure to a trauma event (Meiser-Stedman 2010, *DSM-5* PTSD supplementary items). This unpublished version of the Child Posttraumatic Symptom Scale (CPSS: Foa, Johnson, Feeny, & Treadwell, 2001) is used for children 6-18 years of age and was created before the final PTSD criteria were released in the *DSM-5* (APA, 2013). For analyses, the extra symptom item was dropped, thus resulting in a measure consistent with the 20-item *DSM-5* criteria for PTSD. Children rated the frequency of each traumatic reaction over the past month on a 4-point scale 0 (not at all) to 3 (5 or more times a week). The internal reliability of the measure is high (Cronbach = .93 based on a sample of 233 children assessed 2 months post trauma) (R. Meiser-Stedman, personal communication, 31 March, 2017) and is consistent with studies of the *DSM-IV* version of the measure (.83, Foa et al., 2001; and .90, Nixon et al., 2013) and .89 obtained in the current sample. A clinical cut-off for the Meiser-Stedman's version of the CPSS has not been established, however subsequent to the current study Foa and colleagues published on the psychometric properties and cut-off of their new CPSS for *DSM-5* (Foa, Asnaani, Zang, Capaldi, & Yeh, 2017). This improved measure scaled items on a 0-4 scale. Adjusting Foa et al.'s cut-off of 31 to the scaling of the Meiser-Stedman measure led us to use a cut-off score of 24 to indicate clinical levels of PTS.

The Child Posttraumatic Cognitions Inventory (cPTCI; Meiser-Stedman, Smith, et al., 2009) assessed participants' trauma/stressful event related cognitions. The 25-item self-report indexes maladaptive appraisals relating to beliefs around permanent change and threat (e.g., *I'll never be the same'*, and '*Anyone can hurt me'*). Children 6 -18 years of age respond on a 4-point scale from 1 (don't agree at all) to 4 (agree a lot). The cPTCI's psychometrics are good demonstrating a strong correlation with the CPSS (r = .63), internal reliability ranging from .86

to .93 (Meiser-Stedman, Smith, et al., 2009; Nixon, Ellis, Nehmy, & Ball, 2010) and > .75 across the tested age range (e.g., 6-18 years) and, test retest reliability at .78 (2 months) (McKinnon et al., 2016). Scores ≥ 50 was used to identify participants with clinically significant trauma-related appraisals. This cut-off was within one standard deviation of the mean for children with PTSD (i.e., Meiser-Stedman, Smith, et al., 2009, sample 2,) and aligned with McKinnon et al. (2016) recommended cut-off score of 46 to 48.

The Ambiguous Situations Test (AST) (Vassilopoulos & Banerjee, 2008; Vassilopoulos et al., 2009) measures children's (10 -13 years of age) interpretive bias for *social situations*. It was included as it has been used in several prior interpretative bias studies (thus allowed an opportunity to conduct a replication of previous findings). More importantly, it allowed me to examine whether the biases indexed by the measure created for the study (TIB, described earlier) played a differential role in accounting for PTS versus anxiety or depressive symptoms. The measure consists of 16 ambiguous social situation events children encounter which are followed by two interpretations, one negative self-judgment, the other a benign judgment of oneself or the situation. For example; 'You ask a classmate to help you with a group project for school and he says no' could be a) *He doesn't want us to work together* (negative interpretation) and b) *He has found another classmate to help him with the project* (benign interpretation). Children rated the extent to which these explanations would come to mind if the event happened to them, with a 5-point Likert type scale ranging from 1 (I would not think of it at all) to 5 (I would think of it immediately). In its original delivery, Vassilopoulos and colleagues administered eight of the items at a pre-assessment, and the other eight at a post assessment. I instead used the items to create parallel forms (i.e., the pre-assessment items constituted form A, the post-assessment items, form B). The measure produced two scores - an index of benign/neutral interpretations, and a negative interpretation score, with higher scores indicating a stronger level of bias. Prior research (Vassilopoulos et al., 2009; Vassilopoulos & Brouzos, 2016) reports Cronbach's alpha of .58 -.89 and .53 - .82 (for the negative and benign/neutral interpretations pre/post scales respectively). Cronbach's alphas in the present study were .70 and .66 (benign/neutral scale, forms A and B respectively) and .82 and .61 (negative scale forms A and B respectively).

The following established youth measures of general anxiety and depression symptoms were also used - the Beck Anxiety Inventory for youth (children aged 7-18 years) (BAI-Y: Beck, Beck, Jolly, & Steer, 2005) and the Children's Depression Inventory – Short Form (children aged 7-17 years (CDI-S; Kovacs, 1992). The scores on both measures were reported as scaled T-scores (i.e., mean of 50 and a standard deviation of 10). Cronbach's alpha in the present study was .92 (BAI-Y) and 0.82 (CDI-S).

Procedure

As typically done for these types of studies (Muris, Merkelbach, Ollendick, King, & Bogie, 2002; Vassilopoulos & Banerjee, 2008), written consent was sought from the school principals and then the parent/caregivers of eligible participants. Following informed assent, participant's stress reactions, cognitive style/interpretation bias and mood were assessed on three occasions, baseline (Time 1), two weeks later (Time 2), and 12-14 weeks after baseline (Time 3). Participants completed the questionnaire sessions in groups in an allocated classroom or in the school computer suite or library. The computer test battery was administered online using Qualtrics software, Version (2014) (Qualtrics, Provo, UT). Prior to the first assessment, students were given written and verbal instruction on how to score their answers and completed a series of practice items covering all the measures. Children were asked to complete the questionnaires independently, work at their own pace and, if needed, seek assistance from the researcher or teacher. Participants received an automated prompt if an item was left unanswered; this signalled the option to either complete the item or move on without answering (as per consent procedures).

Results

Preliminary analyses showed differences between samples for two baseline measures (cPTCI and BAI-Y) and the school SES ratings, however these differences were relatively small and when controlled, did not influence any results (see Appendices J for details of sample differences and, K for the percentage of participants above the outcome measures' clinical cut-off). Scores on the CPSS and remaining outcome variables (i.e., cPTCI, BAI-Y and CDI-S) tended to be positively skewed. Examination of the transformed data analyses did not reveal any marked change in findings therefore raw data is reported throughout. Missing and /or incomplete data was observed for 7% and 11% of the sample across Time 2 (2 weeks from baseline) and Time 3 (12 weeks follow up) assessments.

Participants reported a range of traumatic experiences. Eight percent of the sample reported an event that clearly represented a *DSM-5* Criteria A trauma (e.g., assault, road traffic accident, plane crash, death/serious injury of someone close to them) (APA, 2013). Most of the sample (80%) reported stressful but not Criteria *A* events (e.g., bullying, divorce, pet loss/illness, non-life-threatening injury, medical procedures, academic or interpersonal stressors). The remaining reports (12%, n = 64) consisted of ambiguous events that could not be easily categorised (64%, n = 41), non-stressful or non-traumatic event (17%, n = 11), or blank entries (19%, n = 12). The latter may be in part due to participants choosing their right not to disclose their traumatic event and anecdotal conversations with teachers supported this interpretation on several occasions. Nonetheless, the results were the same regardless of whether blank and ambiguous responses for the event were excluded, thus the larger sample was retained (see Appendix L for event response type analyses).

To test my first hypothesis, that interpretative biases would be associated with symptoms, and that this would be more pronounced with PTS and anxiety, I ran a series of correlations (see Table 2).The relative magnitude of correlations with this prediction, although inferred, was confirmed with subsequent significance testing (z = –0.78). As can be seen from Table 2, greater negative interpretative bias, whether measured by the TIB or AST, was significantly correlated with symptom measures, however these relationships were just as strong for trauma and anxiety measures (CPSS, cPTCI, BAI-Y) as they were for depressive symptoms (CDI-S). Benign or positive interpretations were correlated in the expected direction. Again, no differentiation was observed between adjustment domains (anxiety, depression) although it was interesting to note overall the correlations were slightly weaker relative to the negative interpretation – symptom relationships. The two interpretative bias measures (TIB, AST) were correlated with one another (negative interpretive bias: $r = .54$, $n = 540$, $p < .001$; benign/positive interpretive bias: $r = .40$, $n = 540$, $p < .001$). The size of these relationships suggests some, but not complete, overlap of the constructs under study.

Table 2

Bivariate correlations between measures of trauma symptoms, cognitions and affect, and the Test of Interpretive Bias and the Ambiguous Situations Test at Baseline (Ns 530 - 550).

	CPSS	cPTCI	BAI-Y	CDI-S
TIB-negative scale	.38**	.46**	.41**	.42**
TIB-positive scale	-.22**	-.25**	-.23**	-.30**
AST-negative scale	.40**	.40**	.41**	.42**
AST-positive scale	-.22**	-.26**	-.20**	-.30**

Note: TIB-Test of Interpretive Bias (negative and positive scale); AST- Ambiguous Situations Test (positive and negative scale); CPSS: Child Posttraumatic Symptom Scale; cPTCI: child Posttraumatic Cognition Inventory; BAI-Y: Beck Anxiety Inventory for youth; CDI-S: Child Depression Inventory-Short Form.
** $p < .001$.

I next examined how well interpretative bias identified those with elevated symptoms from those who fell within normal limits. Separate logistical regression analyses were performed on the trauma (PTS), maladaptive cognition (cPTCI), anxiety (BAI-Y) and depression (CDI-S) outcome measures. I first entered gender, age, and school index as predictors given their potential influence, then negative interpretative bias (TIB) to examine its unique contribution. All analyses showed that the addition of the TIB improved prediction, with final models summarised in Table 3. The final model for classifying high CPSS symptom children was significant, χ^2 (4, N = 178) = 10.18, $p < .03$, Nagelkerke $R^2 = .08$, accounting for a small proportion of the variance in participant PTS status. The model's predictive capacity was comparably modest, with an overall success rate of 76.4% (sensitivity: 7 %; specificity: 98%). Similarly, the final model for predicting high depression symptom children was also significant, χ^2 (4, N = 175) = 16.09, $p = .003$, Nagelkerke $R^2 = .15$, with an overall predictive capacity of 86% (sensitivity: 14%; specificity: 99%). In contrast, gender, age, and school index did not predict child status for the other variables (cPTCI: χ^2 (3, N= 175) = 7.709, $p = .052$; BAI-Y: χ^2 (3, N= 175) = 6.992, $p = .072$). However, the addition of negative interpretation bias as a predictor did significantly improve identification of case-ness for these variables (cPTCI: χ^2 (4, N= 175) = 17.08, $p = .002$; Nagelkerke $R^2 = .15$, overall prediction: 79%; sensitivity: 9%; specificity: 96%; BAI-Y: χ^2 (4, N= 175) = 13.58, $p = .009$, Nagelkerke $R^2 = .12$, overall prediction: 82%; sensitivity: 6%; specificity: 99%). Overall, negative interpretive bias played a significant role in accounting for child status (high vs. low symptoms). This needs to be qualified by the modest variance explained and the observation that apart from predicting PTS and CDI-S status, sensitivity for other domains (maladaptive cognitions etc.) was extremely low, with negative interpretive bias appearing to be better in identifying children in the low symptom groups (i.e., specificity) (see Appendix M for the logistical regression analysis on the Ambiguous Situations Test).

Table 3

Logistic regression of trauma, maladaptive cognition, anxiety and depression outcome measures as a function of gender, age school index and negative interpretation bias variables.

	Trauma (CPSS)					95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.24	0.37	0.41	.52	1.27	0.61	2.63
Age in years	-0.04	0.10	0.15	.70	0.96	0.78	1.18
School Index	-0.29	0.20	2.16	.14	0.75	0.51	1.10
Negative bias	0.50	0.18	7.44	.00	1.65	1.15	2.37
Constant	-0.77	1.20	0.41	.52	0.47		
	Maladaptive Cognition (cPTCI)					95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.64	0.41	2.40	.12	1.90	0.85	4.24
Age in years	0.27	0.11	0.06	.81	1.03	0.82	1.28
School Index	-0.52	0.22	5.42	.02	0.60	0.39	0.92
Negative bias	0.60	0.20	8.85	.00	1.83	1.23	2.72
Constant	-1.94	1.32	2.15	.14	0.14		
	Anxiety (BAI-Y)					95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.90	0.42	4.50	.03	2.45	1.07	5.60
Age in years	0.16	0.12	1.79	.18	1.17	0.93	1.48
School Index	-0.19	0.22	0.75	.39	0.82	0.53	1.28
Negative bias	0.52	0.21	6.35	.01	1.67	1.12	2.51
Constant	-3.76	1.43	6.89	.01	0.23		
	Depression (CDI-S)					95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.99	0.46	4.61	.03	2.68	1.09	6.57
Age in years	0.05	0.13	0.13	.72	1.05	0.82	1.34
School Index	-0.47	0.24	3.80	.05	0.63	0.39	1.00
Negative bias	0.61	0.22	7.56	.00	1.83	1.19	2.83
Constant	-2.65	1.46	3.28	.07	0.07		

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y= Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form; OR= Odds ratio; CI = confidence interval; LL= lower limit; UL=upper limit.

I next conducted separate hierarchical multiple regressions with trauma (PTS), maladaptive cognition (cPTCI), anxiety (BAI-Y) and depression (CDI-S) symptoms as the outcomes of interest to assess the stability of negative interpretive bias (TIB) overtime [5] (i.e. at 12 weeks follow up) and test the proposal that interpretive bias would account for PTS and other outcomes over time. The order of entry for predictors remained unchanged (i.e., gender, age, school index at Step 1, negative interpretive bias at Step 2). See Table 4 for a detailed summary. After controlling for demographics and school index, the TIB explained an additional 8% of the variance on trauma symptoms, F_{change} (1,148) = 13.60, p < .001, and 4.2% of the variance in participants' maladaptive cognition symptoms, F_{change} (1,149) = 7.27, p < .001. Non-significant results were observed for anxiety, F_{change} (1,149) = 1.76, p = .186 and depression, F_{change} (1,148) = 1.80, p = .182. For each outcome measure however, higher school index was associated with significantly lower symptoms (see Appendices O to R for the TIB and, Appendix S for the AST expanded regression tables). Given the potential of current symptoms to influence follow-up scores, I repeated the regression analyses after controlling for the outcome measure symptoms at baseline (i.e., Model 2 in Table 4). Not surprisingly, initial symptom severity at baseline (T1) was a significant predictor of outcome for all measures at 12 weeks follow up. Of relevance for the present study, negative interpretative bias remained a significant predictor of PTS symptoms at follow-up, although the unique variance accounted for was now very small.

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[5] Test-retest reliability analyses with the bias (Test of Interpretive Bias, Ambiguous Situation Test) and outcome measures (PTS, cPTCI, BAI-Y and CDI-S) showed strong positive correlations over the 12-week assessment period indicating stability of symptoms (see Appendix N for details).

Table 4

Summary of hierarchical regression analysis predicting of trauma, maladaptive cognition, anxiety and depression symptoms: Gender, age, school index, baseline symptoms, negative interpretation bias as predictor variables

		Model 1		Model 2 (baseline symptoms controlled)	
Outcome Variables	Predictors	ΔR^2	F_{change}	ΔR^2	F_{change}
Trauma (CPSS)	Step 1 Control Variables[a]	.038	$F(3,149) = 1.98$	.26	$F(4,147) = 13.03$***[c]
	Step 2 Negative bias	.081	$F(1,148) = 13.58$***[b]	.022	$F(1,146) = 4.58$*[d]
Cognition (cPTCI)	Step 1 Control Variables[a]	.089	$F(3,150) = 4.91$**[e]	.36	$F(4,146) = 20.80$***[g]
	Step 2 Negative bias	.042	$F(1,149) = 7.27$**[f]	.004	$F(1,145) = 0.89$
Anxiety (BAI-Y)	Step 1 Control Variables[a]	.063	$F(3,150) = 3.34$*[h]	.37	$F(4, 146) = 23.10$***[i]
	Step 2 Negative bias	.011	$F(1,149) = 1.76$	.001	$F(1,145) = 0.261$
Depression (CDI-S)	Step 1 Control Variables[a]	.060	$F(3,149) = 3.18$*[j]	.526	$F(4,145) = 40.18$***[k]
	Step 2 Negative bias	.011	$F(1,148) = 1.80$	.010	$F(1,144) = 3.03$

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y= Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form. [a] Control variables: Gender, Age, and School Index. [b-k] details significant variables within each step as follows: [b] Negative interpretation bias, B = 3.095, SE = .839, $p < .001$, School Index, B = -2.012, SE = .895, $p = .026$; [c] T1 trauma symptoms, B = .492, SE = .074, $p < .001$; [d] Negative interpretation bias, B = 1.708, SE = .798, $p = .034$, T1 trauma symptoms, B = .443, SE = .076, $p < .001$; [e] School index, B = -4.193, SE = 1.130, $p < .001$; [f] Negative interpretation bias, B = 2.819, SE = 1.046, $p < .001$, School index B = -4.088, SE = 1.108, $p <$.

001; [g] T1 cognition symptoms, B = .573, SE = .072, $p < .001$, School index, B = -2.135, SE = .993, $p = .03$, [h] School index, B = -2.476, SE = .924. $p = .008$; [i;] T1 anxiety symptoms, B = .526, SE = .060, $p < .001$, School index, B = -1.753, SE = .761, $p = .023$; [j] School Index, B= -2.324, SE = .850, $p = .007$; [k] T1 depression symptoms, B = .637, SE = .053, $p < .001$. * $p < .05$; ** $p < .01$; ***$p < .001$.

For my final hypothesis I ran a series of Chi Square analyses to determine whether a high level of negative interpretative bias at baseline, in those not currently showing elevated symptoms, placed these children at risk of being in a high symptom category at 12-week follow-up for trauma (PTS), cognition (cPTCI), anxiety (BAI-Y), and depression (CDI-S) symptoms. Subsample categories were created using the participants' baseline level of negative interpretive bias and symptom level on the outcome measure. Children were classified as having high or low negative interpretation bias if their TIB score (Z- score) placed them above the 75th or below the 25th percentile respectively. Low outcome measure scores at baseline were defined by values below the measure's clinical cut-off (e.g., CPSS5 ≤ 24, cPTCI ≤ 50, BAI-Y and CDI-S T-score ≤ 60).[6] In sum, two groups were formulated. The first consisted of individuals with high negative interpretation bias and low symptoms at baseline, the second comprised individuals with low negative interpretation bias *and* low symptoms. The subsample groupings (i.e., high bias/low symptom and low bias/low symptom) across the outcome measures was relatively small (see Table 5). In each case however, the number was adequate to satisfy pre-test assumptions and perform the analyses. The results of these analyses are shown in Table 5. Contrary to expectation, children with high negative interpretation bias were not more likely to be categorised in the high PTS group at follow-up than those with low negative interpretation bias, although the proportions were in the expected direction, χ^2 (1, N = 68) = 2.14, $p = .16$. A similar pattern of results was observed for the remaining outcome variables; maladaptive cognition: (cPTCI), χ^2 (1, N = 70) = 1.026, $p = .262$; anxiety; (BAI-Y), χ^2 (1, N = 74) = 2.110, $p = .162$,

[6] The T-score cut-off of 70 for the BAI-Y and CDI-S measures was not used due to an insufficient number of high and low negative interpretation bias cases within this conservative category.

and depression (CDI-S), χ^2 (1, N = 69) =.519, p = .445. Overall the proportion of children with clinically elevated symptoms and high negative interpretation bias at 12 weeks follow up was not statistically different from individuals with low level negative interpretation bias in the clinical range, although in all cases the proportions were in the expected direction. However, it is recognised these analyses were substantially underpowered due to the small cell sizes, which as discussed later, precludes robust interpretation of these findings.

Table 5

Proportion of at risk (high negative bias) children moving to clinical range at 12 weeks follow up on outcome measures of trauma, maladaptive cognition, anxiety and depression.

		Status at 12 weeks follow up	
Variable	Risk status at baseline	Normal range (n, %)	Clinical range (n, %)
Trauma (CPSS)	Low bias / low symptoms	35 (92.1)	3 (7.9)
	High bias / low symptoms	24 (80)	6 (20)
Cognition (cPTCI)	Low bias / low symptoms	35 (92.1)	3 (7.9)
	High bias / low symptoms	27 (84.4)	5 (15.6)
Anxiety (BAI-Y)	Low bias / low symptoms	37 (97.4)	1 (2.6)
	High bias / low symptoms	32 (88.9)	4 (11.1)
Depression (CDI-S)	Low bias / low symptoms	36 (97.3)	1 (2.7)
	High bias / low symptoms	30 (93.8)	2 (6.3)

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form.

Discussion

The present study was the first to use measures of interpretive bias designed to index children's threat-related interpretation bias associated with ambiguity that focused on PTS. I observed the TIB correlated with a previously used measure of bias (e.g., AST) as well as unhelpful trauma-related beliefs. As will be detailed further, when identifying children with high levels of PTS and other symptoms, the TIB showed high specificity but poor sensitivity. Baseline TIB scores did predict PTS, maladaptive beliefs and other symptoms at 12-week follow-up controlling for other known predictors (e.g., school SES), although modest levels of variance were accounted for. However, my prediction that the TIB would identify children at increased risk of developing elevated symptoms over time was not supported. I now discuss and account for these findings in more detail.

The significant relationships between negative interpretation bias and symptom measures (i.e., PTS, maladaptive cognition, anxiety and depression) were of moderate size and these patterns were consistent with prior research that report associations with threat-related/negative interpretation bias and in general child anxiety and depression (Creswell & O'Connor, 2011; Muris & Field, 2013; Muris et al., 2005), as well as PTSD (Ehlers et al., 2003). Moreover, the weak negative relationship observed between the TIB's *positive* scale and symptom measures demonstrate support for the TIB's convergent validity with measures of negative cognition. Contrary to expectation, the relationship for threat-related interpretive bias and depression symptoms was just as strong as that observed for PTS, anxiety, and maladaptive cognitions. This suggests that despite having TIB items focusing on ambiguous *threat* situations, a broader range of negative interpretive biases might also have been indexed, not just threat-related ambiguity associated with PTS. Given the strong association between anxiety and depressive symptoms in youth (Cole, Truglio, & Peeke, 1997) this might reflect a broader, trans-diagnostic mechanism underlying these symptoms (Muris et al., 2005). Interestingly, although the TIB and Ambiguous Situations Test (AST) showed similar patterns of relationships to symptoms, the TIB and AST only showed a moderate correlation with one another. This suggests the TIB might be indexing other elements of cognition beyond that of the AST which has a strong focus on *social* threat situations.

The TIB's capacity to predict children's current symptom status at baseline was mixed. Although significant findings were observed for negative interpretation bias to identify those with elevated PTS and depressive symptoms, over and above demographic and school determinants, its sensitivity was very low (7-14%), and TIB scores did not uniquely account for symptom status with respect to maladaptive cognition or anxiety. My null finding, although unexpected, given the link between threat processing bias and problematic anxiety (Muris & Field, 2013; Muris, Merckelbach, et al., 2000), is consistent with other research that has not observed interpretation bias to predict current childhood anxiety disorder status (Cannon & Weems, 2010). When interpreting their findings, Cannon and colleagues observed that their results may have been partly influenced by the type of measure used to assess interpretive bias (i.e., negative cognition more broadly), although post hoc analyses showed the interpretive bias-anxiety relationship was moderate by female gender. Alternatively, like the present study, Muris et al. (2005) observed that the expected relationship between children's threat perception at Time 1 and anxiety symptoms at Time 2 (i.e., 8 weeks follow up) diminished when baseline anxiety symptoms were controlled. However, whilst initial symptom severity predicted level of anxiety and depression overtime, children's threat perception scores at follow up accounted for additional unique proportion of variance in symptoms of anxiety and depression. Moreover, the findings from the Muris study, and other research that spanned a longer interval than the current study, for example, a 12-month period (Creswell & O'Connor, 2011), did not show evidence of threat interpretation predicting change in anxiety level; rather, anxiety level, over the longer interval, predicted children's subsequent threat interpretation bias. Like the present study, these results were based on data using a community sample. Finally, the TIB was developed to index interpretive biases associated with PTS. Given recent conceptualisations of PTS as not simply an anxiety disorder (APA, 2013), it is possible the failure of the measure to be strongly associated with anxiety may reflect the measure is less sensitive to the generalised interpretations of childhood anxiety and related unhelpful beliefs.

Of interest, I also observed that schools with higher socio-educational advantage (school index) was associated with significantly lower symptoms for each outcome measure. This was not surprising given the known relationship between SES and children's educational and mental health outcomes (Bradley & Corwyn, 2002; Sirin, 2005). Furthermore, all the lower index schools recruited for the study were located within rural communities. Studies exploring the socioeconomic determinants of inequality suggest both school (i.e., geographic location, resource access difficulty; teacher shortages and instructional equipment) and family factors (i.e., low-income households, single parent families) play a role in childhood disadvantage (Sirin, 2005; Sullivan, Perry, & McConney, 2013). Consequently, compared with their urban peers, some children attending the low SES schools may have faced these challenges.

The field needs improved understanding as to the risk a negative interpretation bias might constitute for children *developing* symptoms. Contrary to expectation, negative interpretation bias (i.e., TIB) did not predict the *onset* of significant symptoms at follow-up (e.g., PTS, maladaptive cognition, anxiety and depression) in children who were within normal limits at initial assessment. This finding is in keeping with Cannon and Weems' (2010) research examining processing biases and childhood anxiety and raises the possibility that the tendency to interpret ambiguity in a negative way may have only a negligible effect on children's mental health outcomes. However, as the present study represents the first use of the TIB, the findings are preliminary given the content specificity of the measure remains under investigation. Further, it is possible that not all TIB items captured the ambiguity of the scenarios as well as planned. Although the number of children who exhibited a high level of negative interpretation bias at initial assessment, and then later developed PTS symptoms, were proportionally greater than children with other symptoms at 12 weeks follow up it should be emphasised this did not reach statistical significance. One explanation for the null finding concerns the power of the study. As children were recruited from an unselected population, although the overall sample size was large, the number of individuals who reported a high level of negative interpretation bias but no significant symptoms at baseline was low, resulting in a relatively small subset of individuals with which to examine new onset of significant symptoms. Another explanation includes the somewhat lax TIB cut-off criteria adopted (75th and 25th percentile). On reflection, dichotomising the sample to create the groups for the chi-square analyses could have resulted in a loss of sensitivity in analyses. Subsequent correlational analyses with participants reporting low symptoms at baseline indicated weak but significant relationships between some variables including negative interpretation bias and follow-up trauma-related symptoms (i.e., PTS; r =.28, maladaptive cognition, r =.18) (see Appendix V for these correlations). The sample's adaptive orientation toward a benign interpretation bias (seen by positive TIB scores) may also have reflected some resilience in the sample, mitigating the risk of negative interpretative biases. Indeed, in the overall sample, the TIB performed better identifying children *not* at risk. Despite the explanations offered, it should be stressed that the findings from these analyses were substantially underpowered and therefore cannot be confidently interpreted. Moreover, although the study results focussed upon the effect sizes and not statistical significance per se, many tests were performed which increase the possibility of Type I error. Whilst the moderate effect sizes observed offer some suggestion of possible effects, the reliability of these results remain inconclusive and require replication with larger samples.

The study had a number of strengths. It represents the first occasion interpretative bias related to PTS has been a focus of study in a community sample of children and did this within a short longitudinal design. I also measured a range of symptom domains beyond PTS. I of course acknowledge several limitations. Although significant effort was made to recruit from a range of school types and demographics, the sample may not have been fully representative of the broader child population and consisted of mostly White primary school children. Further, the longitudinal design and type of questionnaire used to assess trauma symptoms was a participation barrier for some schools. High schools in particularly were less available to be involved due to their curriculum priorities. Other non-participating schools felt the type and length of questionnaire battery was not suitable for their students. Although these factors could not be altered, further consultation with the education sector may have improved participation from the broader school community. That said, as seen by the sample size, this was not a barrier for many schools. Other factors may have affected the quality of data. These include some teachers' remarks and reluctance for children to report their 'most traumatic event' fearing this might trigger distress (this was not observed) and/or encouraging children to 'work quickly' (to limit impact on lesson time), boredom or fatigue (anecdotal feedback from some children) and the assessment environment (i.e., classroom noise, unavoidable use of communal areas such as the library or computer room). It is unknown to what extent these factors may have had on the study results, if any, but in most cases, children were compliant with the standardised process and appeared focused during the assessment. Further, although Z-scores were used to standardise and combine the different TIB versions (i.e., Sample 1 dichotomous and Sample 2 Likert scale formats), the use of multiple variants of the TIB resulted in a much restricted range of scores for Sample 1 which may have had some influence on the interpretation of findings. Furthermore, given the limit of self-report (i.e., potential source of bias, selective memory, exaggeration, demand characteristics) the study would have been improved by the inclusion of parent/caregiver informant data, especially in relation to reporting life trauma history.

In terms of avenues for future research, this should include replication with the aim to over-sample high symptom children. As it may take longer for children with negative interpretation bias to exhibit problems, longer assessment intervals would help determine whether children who are not currently displaying symptoms are at increased risk of later new onset problems. The study group comprised of children younger (11 years old) than the peak risk age onset of mental health difficulties, which typically occur during adolescence (De Girolamo, Dagani, Purcell, Cocchi, & McGorry, 2012). Studies with older samples are therefore needed. The TIB measure did not contain Criteria A event scenarios, thus the scenarios may not have evoked enough threat uncertainty around situations more closely resembling traumatic events.

Future research could investigate how to improve the item sensitivity toward traumatic events whilst preserving the ambiguity of the scenarios. Moreover, further development and psychometric evaluation of the TIB would improve its construct validity. Although, the TIB's negative scale demonstrated some convergent validity with other measures of negative cognition, with the degree to which it diverged from less related constructs remains unclear (i.e., discriminant validity). In addition, the domain sampling for the TIB's items was heavily influenced by research findings that led to the development of a trauma belief measure (the cPTCI). This may have restricted the breadth of content in the TIB when it came to assessing children's threat-related interpretation biases (Clark & Watson, 1995). As such, future investigations could consider a broader sampling of the construct under study to ensure adequate representation of the items' content area. Further, to help delineate the conceptual boundaries of constructs (Clark & Watson, 1995), the inclusion of other measures in future research such as the Resilience Scale (Wagnild & Young, 1993) which has good psychometric data for use with youth sample (Ahern, Kiehl, Lou Sole, & Byers, 2006) would add further important information regarding the TIB. Finally, the ability of the TIB to index change in negative threat-related interpretation bias could be examined in the context of intervention research (i.e., Cognitive Bias Modification).

Notwithstanding these limitations, the present study adds to the literature of childhood PTS, demonstrating the existence of ambiguous threat-related interpretative bias following children's exposure of stressful and/or traumatic events. My data did not indicate the TIB's capacity to predict children at later risk, although ambiguous threat-related interpretation biases played a small role in accounting for children's PTS symptoms in this unselected sample. I suggest that further investigation of ambiguous threat-related interpretation bias in the context of child PTS is a fruitful line of research that has the potential to improve our understanding of etiological and maintenance factors of the disorder, and ultimately may lead to testing of new ways to treat trauma-related difficulties.

CHAPTER 3

Study 2

As reported in earlier chapters, the prevalence rate of childhood Posttraumatic Stress Disorder (PTSD) is estimated at 16% (Alisic et al., 2014), indicating many children exposed to traumatic experiences naturally recover (Le Brocque et al., 2010). However, a significant minority do not, and it is argued that dysfunctional appraisals play a critical role in impeding adaptive recovery and contribute to symptom maintenance (Bryant et al., 2007; Ehlers & Clark, 2000). Consequently, current treatments that address children's threat appraisal and/or negative interpretation bias rely mostly upon techniques specific to cognitive behavioural methods (e.g., Cohen, Deblinger, Mannarino, & Steer, 2004; Nixon et al., 2012). However, there are barriers to receiving these treatments, including access, the requirement of specialist delivery (i.e., by trained clinicians) and the fact that treatment is resource intensive (e.g., in terms of cost, regular session attendance and parental participation) (Cohen & Mannarino, 2008). Moreover, systematic reviews of CBT for childhood PTSD suggest that not everyone who receives treatment achieves good end state functioning (Cohen, Berliner, et al., 2000; Stallard, 2006). These issues highlight the need for additional or supplementary cognitive treatment options. Increasingly, research has focused on directly training children to adopt a benign or positive *interpretive* style, particularly in the face of ambiguity or perceived threat. Cognitive Bias Modification of Interpretation methods (CBM-I; MacLeod & Mathews, 2012) have been studied predominantly in the context of general or social anxiety in children but have significant potential for addressing children's trauma related biases. Accordingly, the goal of the current study was to assess the efficacy of a CBM-I program to modify biases and trauma symptoms in an unselected child sample.

Founded upon the research of Mathews and colleagues (Grey & Mathews, 2000; Mathews & Mackintosh, 2000), CBM-I trains an individual to adopt a desired interpretive style using repeated computerised trials (MacLeod et al., 2009). The importance of developing children's adaptive bias, and/or modifying a negative interpretation bias style (i.e., habitual interpretation of ambiguous stimuli in a negative or threatening way) has been driven by the argument that negative interpretative bias is common to all childhood anxiety disorders (Mathews & MacLeod, 2002; Pereira et al., 2017). Hence, the focus of CBM-I research has been two-fold. First, to induce a change in children's interpretive bias style, and second, to evaluate the therapeutic potential of bias modification to reduce psychological symptoms (MacLeod & Mathews, 2012). With respect to anxiety in youth, these proposals are supported by two recent meta-analyses that observed moderate sized effects demonstrating that CBM training can decrease negative bias (negative interpretation of ambiguity) and increase positive/benign bias (positive interpretation of ambiguity) with effect sizes (Hedges' *g*) ranging from 0.52 to 0.70 (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017). The meta-analyses also reported on moderators of mental health, anxiety and depression outcome measures (i.e., age, gender, number/frequency of sessions and type of control condition) that is detailed later. What is not captured by these meta-analyses are some of the more nuanced findings in the area, including: longer-term impacts, more recently published studies, and most relevant to the present study, CBM-I findings in traumatised samples. These issues are now addressed.

Interestingly, a number of studies with unselected samples have demonstrated effects of CBM-I following just one session, typically resulting in youth endorsing a more benign interpretation (in some research, a less negative interpretation) of ambiguity than those exposed to negative interpretation conditioning (e.g., Lau et al., 2012; Lau et al., 2011; Lester et al., 2011a; Lothmann et al., 2011; Muris et al., 2008; Muris et al., 2009; Telman et al., 2013). Broader impacts have been observed with positive bias training leading to a reduction in children's post-training fear avoidance behaviours (Lester et al., 2011a; Muris et al., 2009), increased capacity to cope with psychological challenge in a laboratory setting (i.e., monitored arithmetic task) (Lau et al., 2012) and subsequent adaptive appraisals of stress (Telman et al., 2013). The impact of single trainings on mood, however, has been less robust, with reductions in negative affect observed in one study (Lothmann et al., 2011), whereas others have observed no change in positive (Lau et al., 2011) or anxious mood (Telman et al., 2013). As next discussed, the majority of CBM-I research in youth has tended to focus on *multiple* training sessions with a focus on social anxiety. Consistent with single-trial findings, whether improvements in bias translate to changes in anxiety and mood is somewhat mixed.

CBM-I research using multiple training sessions typically involves a modest amount of training (e.g., between 2-4 sessions) and is accompanied by a range of design variants (i.e., administering positive training only), varying control conditions (i.e., no training versus neutral training), and has been administered across a range of settings (i.e., laboratory, online, and school) and delivery modes (i.e., administered individually, in small groups, in pairs with peers and by parents). Studies with unselected samples have reported a decrease in social anxiety symptoms following three bias training sessions compared with no training controls (Lau et al., 2013; Vassilopoulos et al., 2009; Vassilopoulos, Blackwell, et al., 2012), although despite using similar methodology, this has not replicated in other research (e.g., Vassilopoulos, Moberly, et al., 2012). Similarly, investigations with older youth have also been undertaken. In contrast to findings following relatively brief trainings, de Voogd et al. (2018) administered eight online sessions of CBM-I training over a 4-week period. This training led to a change in positive interpretation bias, although both groups (training and placebo) showed a similar rate of decline in anxiety and depression symptoms over an extended follow-up assessment period (i.e., 3, 6 and 12 months). Salemink and Wiers (2011) also compared the effect of positive CBM-I compared with neutral training (i.e., a combination of positive and negative neutral social scenarios and probes) and reported congruent training effects (i.e., increase in positive bias interpretation) but no change in state anxiety. When training has failed to demonstrate an impact on symptoms (rather than biases), researchers have typically speculated that insufficient training or compliance with training might account for these null results (de Voogd et al., 2018; Salemink & Wiers, 2011). Similar mixed findings are apparent when samples preselected for high levels of anxiety symptoms have been studied. On the one hand some studies have resulted in both bias and symptoms changing (Lau et al., 2013; Vassilopoulos et al., 2009), on the other hand null findings have been observed, for example where either bias changed for both active and control conditions (Chan et al., 2015), or where bias but not symptoms changed (Fu et al., 2015). Taken together these studies demonstrate interpretive biases can be manipulated but changes are not always specific to the intervention condition (possibly reflecting natural developmental changes or a response to training regardless of whether it is active training or not). Finally, symptom reduction is only observed in some cases. The impact of CBM-I for children with clinical levels of anxiety shows both positive and null findings. I review this literature in Chapter 4 where it is relevant to my clinical study of CBM-I with children experiencing PTSD following accident injury.

To my knowledge no study has assessed CBM-I training effects for youth with trauma-related symptoms, however three studies have examined CBM effects in adult analogue trauma designs (Woud et al., 2018; Woud et al., 2012; Woud et al., 2013). These studies trained healthy participants to engage in *specific* appraisals depending on experimental condition (i.e., positive [functional] vs. negative [dysfunctional]) in response to emotional reactions triggered by distressing movies. Participants received CBM training either prior to viewing the film (Woud et al., 2013), or after the film (Woud et al., 2012). Woud et al. (2012) observed a significant interaction of moderate size with the positively trained group showing a significant reduction in trauma-related appraisals relative to the negatively trained group at post-training. Interestingly the changes in the positive CBM appraisal condition reduced further at 1-week follow-up (within-group d = 0.56, relative to pre-post d of 0.26). In addition, the positive training group evidenced fewer intrusions, and less distress caused by their intrusions, than negatively trained group (ds 0.49 – 0.52). In terms of training received *before* the trauma film, individuals who received positive training, compared with those in the negative training group, reported significant improvement (lower scores) on an analogue trauma symptom measure at 1 week follow up (*d* = 0.30) (Woud et al., 2013). Both training groups experienced low levels of intrusions, although compared with the negative group, positively trained individuals reported significantly less intrusion distress (*d* = 0.79) (Woud et al., 2013). A recent investigation of CBM intervention in adults reported similar results, that is, positive training, relative to negative training, led to more adaptive appraisals following analogue trauma exposure (Woud et al., 2018). These studies represent a starting point for the exploration of CBM-I and its potential clinical utility for trauma affected populations, including children. As might be surmised from the literature reviewed earlier, the typically robust effects reported for CBM-I studies with adults might not necessarily generalise to child populations (Jones & Sharpe, 2017; Menne-Lothmann et al., 2014). There is therefore a need to test whether CBM-I works with children who report trauma symptoms after negative events, and to better understand the conditions under which positive effects are shown.

In sum, in the child domain CBM-I, strategies to develop a positive or benign interpretive bias has largely focused upon general or social anxiety. It remains unclear to what extent this training regimen may be useful for children's trauma-related biases and symptoms. The literature suggests CBM-I can be effective for the modification of children's interpretive bias style, although the training effect on *symptoms* has been mixed. Cristea et al.'s (2015) meta-analyses did not find convincing evidence for the clinical utility of CBM-I, nor did it identify moderating factors on mental health or bias outcome. The authors did however find that CBM had a significant effect upon interpretation biases for unselected child/youth samples when delivered in a school setting. Although some factors, such as the number of sessions, did not moderate symptom outcome, many studies within Cristea's review used one CBM session and/or short assessment intervals (1-2 weeks). Further, as noted by the authors, the variability of the quality of studies and some methodology limitations (e.g., grouping of outcome measures, small number of studies and low number of participants in subgroup analyses) precluded the testing of some moderators, limiting the conclusions that can be drawn from their findings. Furthermore, Cristea, Mogoașe, et al. (2015) combined attention training *and* interpretation training studies in analyses which did not allow for the direct testing of moderators with CBM-I alone. Krebs et al.'s (2017) systematic review addressed this issue and found supporting evidence for CBM-I positive training across studies involving unselected child/youth samples, with a small but significant effect on anxiety symptoms (*g* = -0.17). Changes in children's induced biases have been shown to exist beyond the immediate CBM-I intervention phase up to 24 hours (Belli & Lau, 2014), to 3 days (Vassilopoulos et al., 2009) and 1 week later (Chan et al., 2015), with longer intervals not examined in meta-analyses to date. Consequently, there may be sleeper effects of CBM whereby the positive effects on biases and symptoms (or both) might not be apparent without adequate follow-up.

My study had two key aims. First, to assess in a longitudinal design whether four CBM-I positive training sessions would reduce children's negative interpretation biases, increase (or strengthen) children's adaptive interpretation style, and consequently influence children's posttraumatic stress. Second, to test potential moderators of outcome (e.g., baseline biases and symptoms, gender, and age) to develop a more nuanced understanding for whom CBM-I works. I used an unselected community school sample, with positive and control training delivered over 2 weeks. I predicted that trauma-related negative interpretation biases would positively correlate with trauma and mood symptoms, as well as with maladaptive cognitions. I also hypothesised that positive bias training, compared with placebo training would lead to higher level of endorsement of benign interpretations and lower levels of endorsement for negative interpretations post training. Finally, I was able to examine longer-term outcomes with post-training assessments at 2-weeks, 3-months, and 6-month follow-up. Notably, I examined whether the CBM-I training could have some protective influence and lower the risk of children developing later maladjustment.

Method

Participants

A total of 396 students were recruited from six [South Australian] private and public primary schools. Participating schools ranged from low to high levels of disadvantage in accordance with the Index of Community Socio-Educational Advantage (ICSEA: Australian Curriculum Assessment and Reporting Authority, 2014). Participants were mostly White (consistent with the demographics of the region) and aged between 9 to 13 years (M = 10.9, SD = 0.9; 47% male) (see Table 1). Children under the guardianship of child protection services and/or individuals identified by their teacher or parent(s) as likely to have difficulty with questions due to developmental delay, literacy or language problems represented exclusion factors, however no child met these criteria. Ethical approval was received from the relevant ethics committees. An 'opt-out' consent process was approved by ethics however one education body required active permission (i.e., opt-in, signed consent from parents/caregivers). Thus 44% of the sample were recruited via the 'opt-out' method. All students provided written assent.

Participants were randomised into the CBM-I or control condition using a block randomisation process within each class. Preliminary inspection of the training data revealed eleven participants (5 CBM-I, 6 Controls) did not undertake two or more of the training sessions and were dropped from the data pool to curtail any influence of inadequate training exposure (as per Lau & Pile, 2015). Thirteen participants (8 CBM-I, 5 Controls) were excluded from analyses due to non-compliance with the training. I anticipated minimal attrition at the 2-week assessment (< 2%) and factored up to 20% attrition by final follow–up. Power analysis showed that to detect a between-group Cohen's d effect size of 0.30 (Cohen, 1992), a conservative estimation from previous non-clinical child CBM-I research (Vassilopoulos & Brouzos, 2016; Vassilopoulos, Moberly, et al., 2012), 116 participants per group was required (Hedeker, Gibbons, & Waternaux, 1999). The present sample size was therefore deemed adequate. Figure 1 shows the flow of participants through the study.

Table 1

Demographic and trauma characteristics

Variable	Positive training (*n*=200) *M* (*SD*)	Neutral training (*n*=196) *M* (*SD*)	Total participants (N=396) *M* (*SD*)
Age	10.92 (0.94)	10.96 (0.93)	10.94 (0.93)
Range in years	9-13	9-13	9-13
Male sex	48.5% (*n* = 97)	46% (*n* =90)	47% (*n* = 187)
Ethnicity			
White	94% (*n* = 188)	95.4% (*n* = 187)	95% (*n* = 375)
Other	6% (*n* = 12)	4.6% (*n* = 9)	5% (*n* = 21)
Grade			
Year 5	40% (*n* = 80)	39% (*n* = 76)	40% (*n* = 156)
Year 6	29% (*n* = 57)	32% (*n* = 62)	30% (*n* = 119)
Year 7	31% (*n* = 63)	29% (*n* = 58)	30% (*n* = 121)
School region			
Metropolitan	46% (*n* = 91)	45% (*n* = 89)	45% (*n* = 180)
Regional	54% (*n* = 109)	55% (*n* = 107)	55% (n = 216)
School type			
Public	56% (*n* = 112)	54% (*n* = 106)	55% (*n* = 218)
Private	44 % (*n* = 88)	46% (*n* = 90)	45% (*n* = 178)
School Index Range			893-1136
Trauma type*	(*n* = 61)	(*n* =59)	(*n* =120)
Accident (e.g., RTA)	11.5% (*n* = 7)	8% (*n* = 5)	10% (*n* = 12)
Interpersonal	46% (*n* = 28)	34% (*n* = 20)	40% (*n* = 48)
Death/ illness	11.5% (*n* = 7)	15% (*n* = 9)	13% (*n* = 16)
Animal event	19.5 % (*n* = 12)	12% (*n* = 7)	16% (*n* = 19)
Miscellaneous	11.5% (*n* = 7)	31% (*n* = 18)	21% (*n* = 25)
Trauma Subsample			
CPSS (*M*, *SD*)	17.39 (12.87)	18.81 (13.43)	18.09 (13.11)
Range	0-54	0-50	0-54

Note: School index with *M* of 1000 and *SD* 100 (higher scores reflect higher advantage), range based on the six schools involved.

*Trauma type reported for only those who reported consistent trauma throughout the study. Accident refers to serious accident such as a road traffic accident (RTA). Interpersonal trauma could include witnessing events (e.g., an assault). Death/illness refers to that of a relative or close friend. Animal refers to being attacked by an animal or witnessing one's pet being attacked or dying (of traumatic or natural causes). Miscellaneous refers to a broad range of events from being left at home alone to being exposed to scary movies.

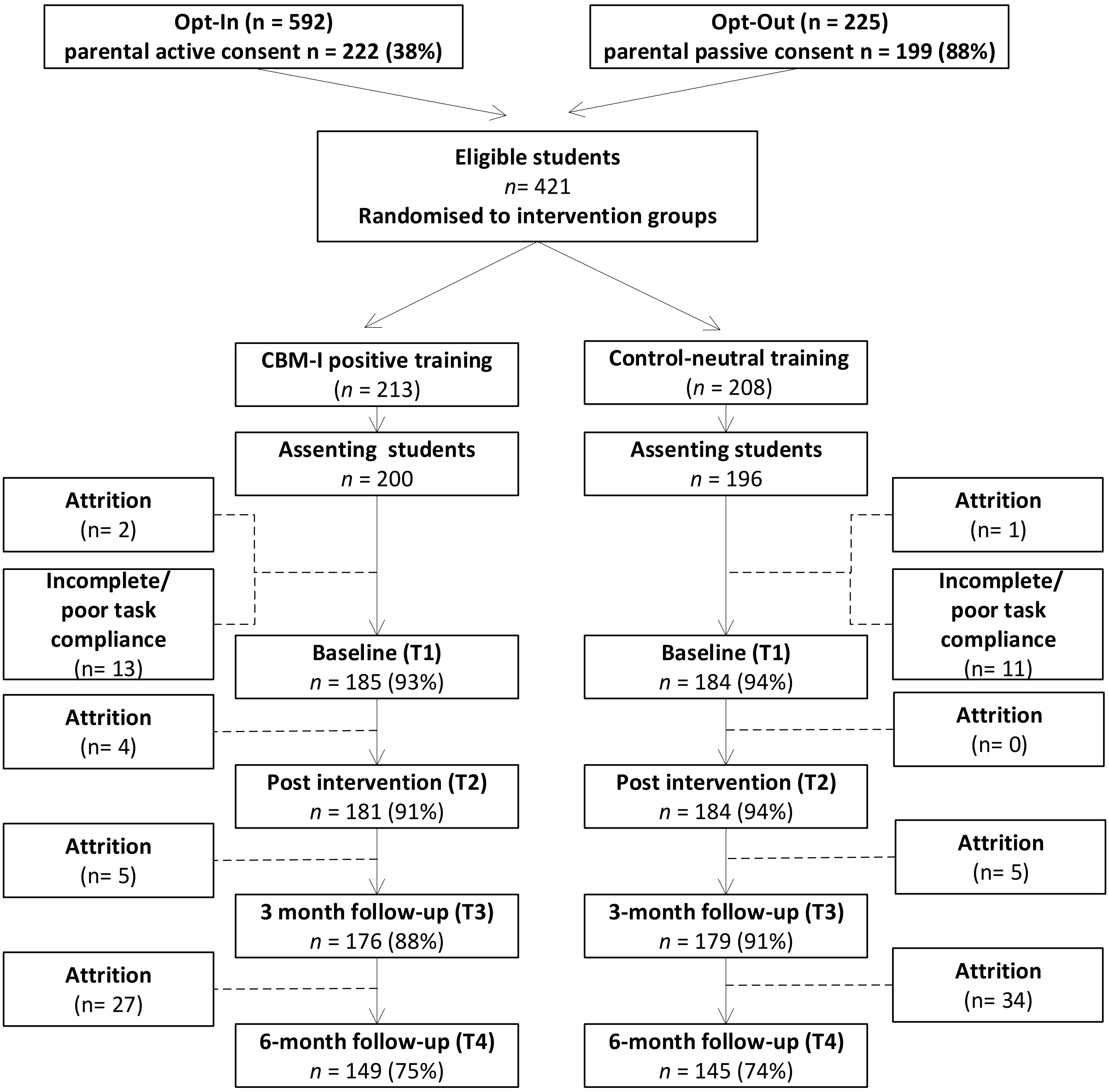

Figure 1. Participant flow chart.

Measures

Children's posttraumatic stress reactions were assessed using an adapted 21- item measure based on the Child Posttraumatic Symptom Scale (CPSS; Foa et al., 2001) - Meiser-Stedman's (2010), DSM-5 PTSD supplementary items. This unpublished version was developed prior to the final PTSD criteria being released in the Diagnostic and Statistical Manual of Mental Disorders, (5th ed.; *DSM-5* American Psychiatric Association [APA], 2013) and contained an extra item. To align with the DSM-5 criteria for PTSD, analyses were based on the 20 items reflecting DSM-5 criteria. Children's symptom severity over the past month was assessed on a 4-point Likert scale with scores ranging from 0 (*not at all or only one time*) to 3 (*5 or more times a week/almost always*). The measure has excellent internal reliability (α = .93, R. Meiser-Stedman, personal communication, 31 March, 2017) and was comparable to research using the *DSM-IV* version of the measure (.83, Foa et al., 2001; .90, Nixon et al., 2013). The internal consistency in the current sample was .92. As the Meiser-Stedman measure did not have a published cut-off score I used the psychometric data from the new CPSS for DSM-5 (Foa et al., 2017) to generate an appropriate threshold. Foa's measure scaled items on a 0-4 scale, thus considering the scaling differences, and Foa et al.'s (2017) cut-off of 31, a cut-off score of 24 or higher was used to indicate clinical levels of posttraumatic stress (PTS).

The Child Posttraumatic Cognitions Inventory (cPTCI; Meiser-Stedman, Smith, et al., 2009) is a 25-item self-report measure of children's unhelpful appraisals following a traumatic or frightening event. Its two subscales assess appraisals pertaining to beliefs around threat and permanent change (e.g., '*Nothing good can happen to me anymore',* and *'Bad things always happen'*). Reponses were scored on a 4-point Likert scale (1- *don't agree at all* to 4 - *agree a lot*). The cPTCI correlates strongly with the CPSS (*r* = .63), and internal reliabilities range from .91 to .93 (Leeson & Nixon, 2011; Meiser-Stedman, Smith, et al., 2009); test-retest reliability is .78 (2 months) (McKinnon et al., 2016). Internal reliability was .94 in the present study. As per McKinnon et al. (2016), we used a cut-off of 47 or higher to reflect a clinical level of problematic appraisal.

The Ambiguous Situations Test (AST; Vassilopoulos & Banerjee, 2008; Vassilopoulos et al., 2009) indexes children's benign and negative interpretive bias for social situations. The measure's 16 ambiguous social situations describe routine events children encounter (e.g., peer and classroom interactions) and children are presented by two interpretations of the event - one negative interpretation and one benign interpretation. For example; '*You invite a classmate to* *come to your home to play and he looks at you laughing'*; negative interpretation (*He thinks it's a stupid idea and he laughs at you)* and a benign interpretation (*He likes the idea)*. Children rate the degree to which they endorse each interpretation on a 5-point Likert scale ranging 1 (*I would not think that at all*) to 5 (*I would immediately think that*). A total benign and negative score was produced, with higher scores indicating stronger bias. Internal reliability of the negative scale has been shown to range between .77 and .82 and between .53 and .76 for the benign subscale (Orchard et al., 2017; Vassilopoulos et al., 2009; Vassilopoulos & Brouzos, 2016). In the current study alpha was .88 and .81 for the negative and benign subscales respectively.

The Test of Interpretive Bias scale (TIB; Hogan & Nixon, 2017 unpublished measure see Appendix E) is a 24-item self-report measure I developed to index children's negative and benign interpretive bias relating to perceived threat. Based upon the research of Vassilopoulos and colleagues (2008; 2009) and drawing upon threat biases pertinent to PTSD sufferers, the items describe ambiguous scenarios children face (e.g., peer interaction, school/routine events), followed by a benign/positive and a negative threat-related interpretation. For example, 'Something unexpected happened as you walked into the classroom. You think, *I should always be ready* (negative) and, *It is unlikely to happen again* (benign/positive). Children were asked to imagine the situation was happening to them and indicate how much they agreed or disagreed with each interpretation on a 4-point scale ranging from 0 (*Disagree a lot*) to 3 (*Agree a lot*). The negative and benign/positive interpretative responses were presented in fixed random order. Sum total scores for the negative and benign/positive interpretive bias were created with higher scores indicating stronger interpretive bias. Moderate correlations have been reported between the TIB and the CPSS ($r = .42$) and cPTCI ($r = .55$) (Hogan & Nixon 2017 unpublished measure, as cited in Chapter 2). The authors report test-retest reliability observed over a 3-month period was .76 and .72 for the negative and positive/benign scale, respectively, and .73 (negative) and .65 (benign/positive) over a 6-month interval. Internal reliability was .84 (negative) and .76 (benign/positive) in the current study.

The following established measures were used to index participant's depression and anxiety symptoms: The Children's Depression Inventory-Short form (CDI-S; Kovacs, 1992) and the Beck Anxiety Inventory for youth (BAI-Y; J. S. Beck et al., 2005); T scores reported for both. Cronbach alphas for the present study were .86 (CDI-S) and .94 (BAI-Y).

Affect Rating Scale: Participants were asked to rate how they felt immediately before and after completing each training session on a 5-point rating scale (1 = low mood, 3 = neutral, to 5 = high mood).

Cognitive Bias Training

The training task was modelled upon the CBM-I paradigm (MacLeod & Mathews, 2012; Mathews & Mackintosh, 2000; Mathews & MacLeod, 2002). It involved a series of ambiguous scenarios that were resolved by the completion of a word fragment. The scenario content for the present research drew upon themes drawn from previous research on traumatised children's beliefs and biases such as vulnerability to danger and being changed for the worst as a result of the trauma (Ehlers et al., 2003; Meiser-Stedman, Smith, et al., 2009; Salmon et al., 2007); for ethical reasons the scenarios were designed to present only a mild level of threat. The development of the scenarios involved an independent review by three raters who assessed their degree of ambiguity and age appropriateness. Average agreement of both the ambiguity and developmental relevance across the three raters was 93% (positive scenario) and 86% (neutral scenarios). The task was piloted with six children (aged 9-13 years) to check their understanding of the scenarios and wording of questions, with minor adjustments made in response to their feedback. Four trainings were provided which accommodated the schools' timetable constraints but met the research requirement that it would reflect sufficient training dose given previous CBM research showing change in biases and attenuation of symptoms following three sessions (Vassilopoulos, Blackwell, et al., 2012).

The CBM-I training sessions were administered online via a web browser using Qualtrics software, Version (2014) (Qualtrics, Provo, UT). Children were able to monitor the number of completed trials via a graphical linear gauge, positioned at the header of the webpage, which automatically registered their progress. The tracking indicator was aimed at improving participant engagement and sense of achievement and to minimise user dissatisfaction (e.g., boredom associated with the repetitive trials) previously reported with CBM-I training (Lau, 2015). Children were instructed to imagine the scenario happening to themselves as self-imagery is suggested to maximise the effectiveness of training (Mathews & Mackintosh, 2000; Vassilopoulos, Moberly, et al., 2012). Scenarios were presented in text, along with a simple illustration/photograph and voice over to assist readability and deeper learning (Mayer, 2008). The trial segments were presented on successive screens (see Figure 2 for positive and neutral trial example as well as Appendix W for other examples demonstrating the items' ambiguity and domains of threat). Once completed the trial could not be revisited. The ambiguous scenario was three to five lines in length with a word missing in the last sentence (screen 1). The fragmented word with a reminder of the scenario was presented next (screen 2). Completion of the word resolved the ambiguity of the scenario which reflected a benign/positive or neutral interpretation. Children received a comment on their chosen letter and the completed word (screen 3). A comprehension/confirmation question followed (screen 4) along with corrective feedback (screen 5) to check the individual both understood the meaning of the scenario and to further reinforce the intended training bias (positive group only). Participants in the training and control conditions completed the same scenarios which had different word fragment and corrective feedback (as shown in Figure 2).

Training performance accuracy was used as a check of compliance, as measured by the participants' responses to checks during the training orientation; participants answered 'correctly' for 96% of the items indicating good task compliance.

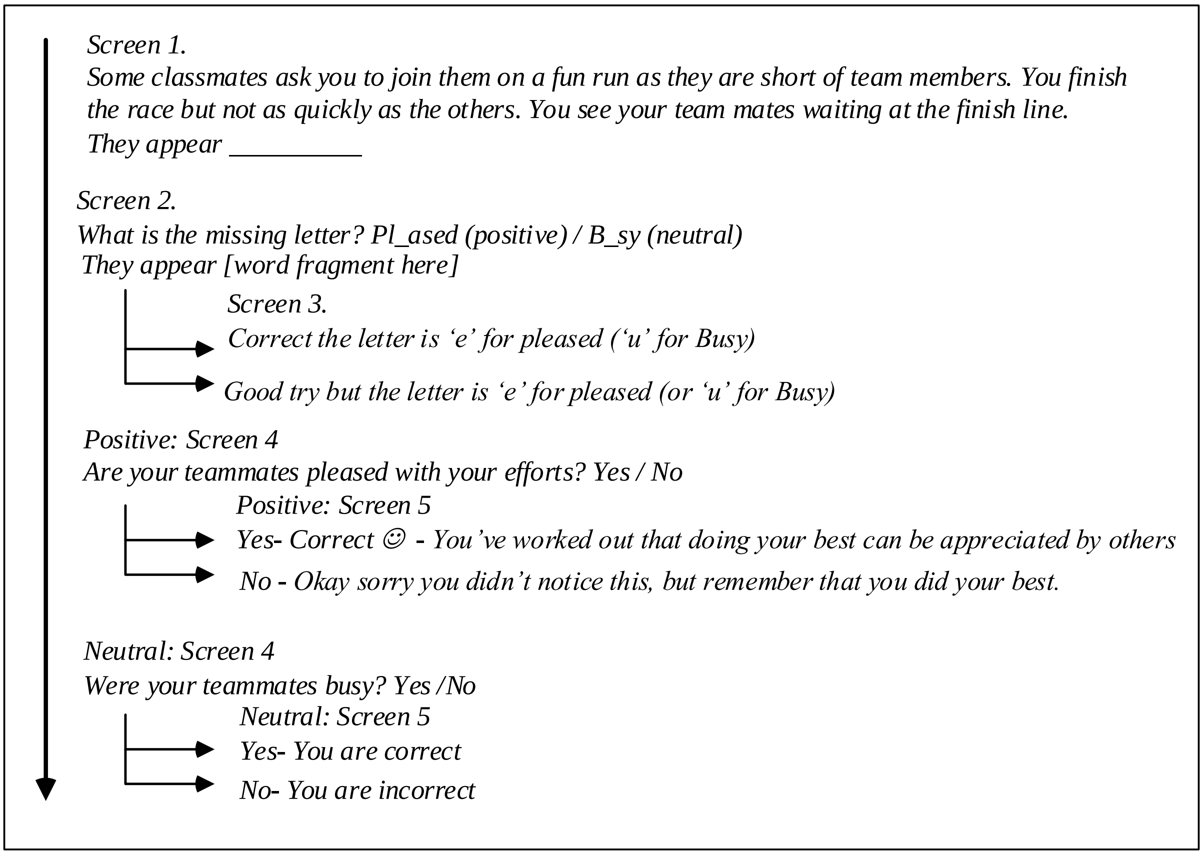

Figure 2. Example of CBM-I positive and neutral training trial.

Procedure

Participants' interpretation bias style, stress reactions and trauma-related cognition and mood were assessed on four occasions: baseline – that is, one week prior to training (Time 1; T1); 4 weeks later, which was one week after training (Time 2; T2); 12-14 weeks after baseline (Time 3; T3); and 24 weeks after baseline (Time 4; T4). Prior to the first assessment, students received written and verbal instruction on how to complete measures and completed practice items. On average the questionnaires took approximately 45 minutes to complete.

One week following the baseline assessment participants completed two CBM-I sessions a week (with a minimum of two days between training sets), over a two-week period. Participants completed affect rating scales prior to and immediately after each CBM-I training session. In total participants completed 80 different training trials (20 per session). Each training session took between 20-30 minutes. In the initial training session, participants were given instructions (written and audio) on the training task, completed an imagery exercise (holding and biting a piece of lemon) shown to enhance the effect of CBM training (Holmes, Mathews, Dalgleish, & Mackintosh, 2006; Lothmann et al., 2011), and then undertook a practice trial (e.g., a different scenario from the actual training trials). Participants completed questionnaires and CBM-I sessions in rooms where multiple computers were available (e.g., their classroom, or in the school library, or computer suite). To help conceal the training objective, children were informed that the task involved thinking about and solving unclear situations. Participants were asked to work independently at their own pace and told not to converse or discuss the task with their peers. Wherever possible children were grouped according to the assigned condition but seated at some distance from each other. Children completed post and follow-up questionnaires in groups at the relevant time intervals. Control participants were offered the positive CBM-I training after the completion of the last follow-up.

Statistical Analyses

All analyses were performed using IBM SPSS statistics (Version 25). Statistical significance (two-tailed) was set at $p < .05$. Normality assumptions were violated for the CPSS and other outcome measures (i.e., cPTCI, BAI-Y, CDI-S) indicating a positive skew, although the residuals from analyses approached normality. Transformation of the data did not alter the final results therefore raw data was maintained for all analyses and is reported throughout. To assess randomisation at the school/classroom level the nesting of children within the schools was examined. Estimates of interclass correlation coefficients were very small indicating a negligible effect of variability due to school level; therefore, data was analysed as a two rather than three level of analysis (Heck, Thomas, & Tabata, 2010). Linear mixed modelling (LMM) with planned pairwise comparisons was used to analyse the effect of CBM-I intervention with key outcome variables (i.e., CPSS, cPTCI, BAI-Y and CDI-S) and interpretive bias measures (i.e., TIB and AST). This statistical approach has several advantages for use with longitudinal data sets (Krull, Cheong, Fritz, & MacKinnon, 2015). First, the inclusion of both fixed (e.g., treatment conditions, gender, age) and random factor variables (e.g., subject) within the same analyses allows processes occurring within (i.e., the effect of CBM-I training for individuals overtime) and between individuals (i.e., differences in CBM-I conditions) to be examined simultaneously. Second, the mixed modelling technique has capacity to accommodate non-independent observations that occur with repeated measure assessment (Krull et al., 2015). Lastly, the model's maximum likelihood estimation enabled the retention of cases with missing data and attrition (West, 2009). LMM was also used to assess moderators of gender and age. Between and within-group effect sizes (Cohen's *d*) were calculated. Effect sizes were reported with the typical interpretive conventions: small .20, medium .50 or large .80 (Cohen, 1992). Chi-square analyses was used to assess the preventive benefit of CBM-I training for at risk children. Change in participants' current mood state at each training was investigated with a series of 2 × 2 repeated measures ANOVA.

Results

Preliminary analyses

There were no significant differences between the CBM-I and control groups at baseline across for all outcome measures (p's > .06). The mean number of training sessions completed by participants was 3.80 (CI_{95} [3.74, 3.86]), that is, approximately 95% or 76 of the 80 trials were completed and this did not differ significantly between groups ($p = .65$).

Significant differences were reported between those recruited via opt-in and opt-out methods on two of the 12 demographic and outcome variables assessed: the BAI-Y anxiety outcome measure and the AST interpretation bias positive scale. Children recruited via the opt-out method reported higher anxiety and less positive interpretations of ambiguous social situations, although the mean difference between the groups was within the normal range on both measures (d = 0.24 to 0.31). Significant differences were also found between school type (e.g., public vs private) and region (e.g., metropolitan vs regional). This was expected however as a greater number of children from private schools, recruited via the opt-out method, were located in a regional area.

Inter-correlations of interpretation bias and outcome measures

Correlational analyses between trauma-related interpretive biases and symptoms of PTS, anxiety and depression are shown in Table 2. As suggested earlier in Chapter 2, the relative magnitude of the correlations was inferred and later confirmed with significance testing (z=-0.78). As noted in study one (Chapter 2) these indicated that negative interpretation bias (TIB and AST) was significantly correlated with trauma-related symptoms, anxiety and depression. Although the reported findings are similar to the Chapter 2 correlational analyses, which used the combined sample, some differences between the previous and the current study results were observed. My prediction this relationship would be stronger for trauma and anxiety symptoms (CPSS, cPTCI, BAI-Y) was not supported with depression (CDI-S) correlating just as strongly with the negative bias measure. Results for the benign/positive interpretations showed significant correlations in the expected direction. A significant and moderate correlation was observed between the two interpretive bias measures (TIB and AST negative scale $r(358) = .63$, CI_{95} [.56, 0.69], $p < .001$; positive scale $r(357) = .51$, CI_{95} [0.43, 0.58], $p < .001$). This suggests some overlap in measurement of similar constructs. This outcome was not entirely unexpected given the generalisability of threat-related interpretive biases across psychological disorders (Mathews & MacLeod, 2005) and, given some scenarios in the TIB involved social interactions children typically encounter. Nonetheless, the less than perfect correlation indicates divergence between two bias measures and suggests the TIB indexes threat-interpretive biases beyond those related to social situations.

Table 2

Bivariate correlations between outcome measures of trauma, maladaptive cognitions, anxiety and depression and the Test of Interpretive Bias and the Ambiguous Situations Test at Baseline (Ns 357- 358).

	CPSS	cPTCI	BAI-Y	CDI-S
TIB-negative scale	.43**	.54**	.49**	.50**
TIB -positive scale	-.24**	-.28**	-.27**	-.35**
AST-negative scale	.45**	.49**	.49**	.50**
AST- positive scale	-.28**	-30**	-.24*	-.36**

Note. TIB-Test of Interpretive Bias (negative and positive scale); AST- Ambiguous Situations Test (positive and negative scale); CPSS: Child Posttraumatic Symptom Scale; cPTCI: Child Posttraumatic Cognition Inventory; BAI-Y: Beck Anxiety Inventory for youth; CDI-S: Child Depression Inventory-Short Form.

** $p < .001$.

Effect of CBM-I intervention training on symptom outcome measures

I conducted analyses on the primary outcome variables and interpretive bias measures for both the full and clinical subsamples. Table 3 and 4 summarises the trauma related measures (i.e., CPSS and cPTCI) and mood (i.e., BAI-Y, CDI-S) fixed effects for both samples at post-treatment (T2), and at three (T3) and six (T4) month follow-up. The primary goal of this study was to assess the effect of the positive CBM-I training on participants' trauma symptoms and biases. Specifically, participants were asked to report symptoms on the CPSS in response to the same event identified at baseline for subsequent assessments. However, a significant number reported different events at these assessments. Consequently, this potentially limits the interpretation of the results because there is no way to reliably determine the effect of CBM-I training on participants' trauma symptoms if the reported event changes over time. Therefore, analyses using the CPSS was restricted to include only those who had cited the *same* traumatic event throughout assessments (n = 125).

Contrary to predictions, group by time interaction effects were not significant when analysing the entire sample, indicating that changes in trauma, maladaptive beliefs and anxiety symptoms over time did not differ between the CBM-I conditions. However significant effects of time were observed demonstrating that both groups showed reductions across all measures with the exception of the CDI-S. I did anticipate seeing intervention effects when analyses focused on those already showing clinical levels of symptoms at baseline (clinical subgroup), however these analyses generally produced a similar pattern of results (i.e., main effects of time but non-significant interaction effects). An exception was seen for participants in the clinical range on the BAI-Y where larger reductions overall were seen in the CBM-I group relative to controls, with a significant reduction observed between pre and post-treatment relative to controls (see Table 4).

Results from the interpretive bias measures (TIB and AST) with the full sample indicated significant main effects of time for the negative and positive bias scales (see Tables 5 and 6 respectively). Thus, both groups showed reductions in negative and improvement in positive interpretations of ambiguity, although there was no significant group by time interactions for three of the four analyses. A significant interaction was present for negative bias scores on the AST. Inspection of the pairwise comparisons revealed control participants experienced minimal change in negative biases. In contrast, participants who received the CBM-I training reported a significant reduction in negative interpretation bias when processing social situations. Similar to the findings on the main symptom outcomes, significant main effects of time were present for the TIB and AST clinical subsamples in terms of negative and positive bias scales but no significant group by time interactions, although near significant trends were reported for the TIB negative scale (p = .06) and AST positive scale (p = .07). As will be elaborated upon later, inspection of within-group effects sizes did suggest these were larger for the intervention group relative to controls, especially across the T1 to T2 interval, however this did not translate to reliable (i.e., statistically significant) overall interactions.

Moderator Analyses

Overall there was little evidence that age and gender moderated these outcomes. Of the 32 analyses (i.e., 16 based upon the full sample, 16 based on those above the clinical cut-off), only two were significant. A 3-way interaction was observed on the BAI ($F(3, 368) = 2.62$, $p = .05$), which showed in the full sample that age moderated anxiety outcomes. Dissection of the data revealed that the significant decline in anxiety for younger children was similar over time for both conditions (CBM-I; $d = 0.27$, $p < .02$, CI_{95} [0.07, 0.47]; Controls, $d = 0.33$, $p < .01$, CI_{95} [0.12, 0.54]), whereas older children in the CBM-I group reported a greater and significant reduction in anxiety by T2, that is post-intervention ($d = 0.21$, $p < .02$, CI_{95} [0.00, 0.42]), compared with similar age controls ($d = 0.04$ *ns*). Further, the AST measure of negative social interpretation bias (3- way interaction, $F(3, 192) = 2.70$, $p = .047$), suggested boys and girls above the clinical cut-off performed differently on CBM-I. Unpacking this interaction indicated that regardless of group, boys reported a significant reduction in the level of negative interpretation bias by T2 (CBM-I; $d = 0.57$, $p < .03$, CI_{95} [0.01, 1.11]; Controls, $d = 0.73$, $p < .01$, CI_{95} [0.21, 1.23]). In contrast, girls who received the CBM-I reported a significant reduction in the level of negative interpretive bias at T2 ($d = 0.94$, $p < .001$, CI_{95} [0.43, 1.44]) whereas controls did not ($d = 0.08$, *ns*). Further details regarding the moderator analyses are provided in Appendix T.

Training effect on mood

In line with prior research, I also examined whether there was any change in participants' mood following each CBM-I training set (remembering there were 4 such trainings), using the entire sample. Group mean differences for mood prior to all four training sets was non-significant (all *p*s $\geq .28$, see Table 7 for all analyses). On average children's mood prior to a training set was 3.98, indicating participants' mood was positive and slightly elevated prior to the training exposure (where 1 = mood low, 3 = neutral, to 5 = high mood). Overall there was a pattern of improved mood in the CBM-I condition relative to controls, with significant interactions observed at the first and second trainings.

Can CBM-I lower the risk of developing later maladjustment?

I hypothesised that CBM-I training might have a preventative benefit for children reporting high level of negative interpretation bias at baseline but who were not yet displaying clinical levels of symptoms. I examined a 'high bias/ low symptom' subsample based on participants' baseline level of negative interpretation bias and symptoms. Specifically, children were included if baseline scores on the TIB placed them above the 75th percentile of the entire sample and they were below the clinical cut-off on the outcome measure of interest (e.g., CPSS < 24, cPTCI < 47, BAI-Y and CDI-S < 60 T-score). Descriptive data for these analyses is shown in Table 8. The sample size available for CPSS analysis was small, given this was restricted to those who reported on the same trauma throughout the study. Overall the proportion of at-risk children in the CBM-I condition who remained in the normal range at follow-ups was not significantly lower than controls. Statistical results were as follows: for trauma symptoms (CPSS), at 12-week follow-up, χ^2 (1, N = 14) = 0.53, p = .47; and 24 week follow up, χ^2 (1, N = 11) = 0.00, p = 1.00; maladaptive cognition (cPTCI), χ^2 (1, N = 25) = 0.49, p = .484; and χ^2 (1, N = 17) = 0.17, p = .682; anxiety (BAI-Y), χ^2 (1, N = 36) = 1.69, p = .193, and χ^2 (1, N = 27) = 0.06, p = .809; and depression (CDI-S), χ^2 (1, N = 37) = 0.67, p = .412, and χ^2 (1, N = 29) = 0.51, p = .474. In sum, the positive CBM-I training had no preventive merit in reducing a participant's risk of developing of new anxiety or mood problems, although these analyses were likely hampered by sample size/power issues.

Table 3. Model estimates, within group effect sizes and Type 3 fixed effects of time, group and group by time on trauma and maladaptive cognition outcome measures.

		Model estimates and effect sizes						Type III fixed effects								
		CBM-I			Controls			Time			Group			Group × time		
Measure	Time	*M*	*SE*	*d*	*M*	*SE*	*d*	*F*	*dfs*	*p*	*F*	*dfs*	*p*	*F*	*dfs*	*p*
CPSS	1	17.76	1.68		18.68	1.69										
(n=125)	2	13.93	1.69	0.29	15.78	1.70	0.22									
	3	12.84	1.67	0.08	14.84	1.68	0.07									
	4	9.85	1.74	0.22	12.51	1.80	0.17	11.38	3,316	**.001**	.795	1,131	.37	.189	3,316	.90
Clinical	1	33.61	2.88		34.25	2.73										
(n=38)	2	26.66	2.92	0.56	29.58	2.88	0.36									
	3	23.11	2.88	0.29	26.00	2.77	0.29									
	4	18.65	3.13	0.34	19.47	2.94	0.50	11.15	3,93	**.001**	.338	1, 41	.56	.207	3,93	.89
cPTCI	1	44.57	1.17		45.38	1.19										
(n=368)	2	40.57	1.18	0.26	44.11	1.18	0.08									
	3	39.66	1.18	0.06	40.86	1.18	0.21									
	4	37.46	1.28	0.13	41.20	1.29	0.02	10.74	3,899	**.001**	3.08	1,396	.08	2.45	3,899	.06
Clinical	1	61.84	1.87		59.94	1.75										
(n=135)	2	51.44	1.93	0.68	54.37	1.83	0.36									
	3	49.58	1.92	0.12	49.52	1.81	0.32									
	4	45.41	2.14	0.25	49.21	2.06	0.02	21.80	3,339	**.001**	.419	1,164	.51	1.72	3,339	.16

Note. CBM-I = Cognitive Bias Modification-Interpretation; *d* = Cohen's *d* (within-group mean difference); CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory. Fixed effect *p* <.001 is in bold.

Table 4. Model estimates, within group effect sizes and type 3 fixed effects of time, group and group by time on anxiety and depression outcome measures.

		Model estimates and effect sizes						Type III fixed effects								
		CBM-I			Controls			Time			Group			Group × time		
Measure	Time	*M*	*SE*	*d*	*M*	*SE*	*d*	*F*	*dfs*	*p*	*F*	*dfs*	*p*	*F*	*dfs*	*p*
BAI-Y	1	51.89	1.06		51.56	1.07										
(n=368)	2	49.17	1.07	0.19	51.03	1.06	0.04									
	3	47.72	1.07	0.10	47.18	1.06	0.28									
	4	45.97	1.14	0.12	46.66	1.15	0.04	13.50	3,907	**.001**	.115	1,395	.73	2.25	3,907	.08
Clinical	1	71.70	1.94		69.81	1.92										
(n=93)	2	64.98	2.01	0.49**	67.16	1.97	0.20									
	3	61.38	2.03	0.26	59.01	1.99	0.60***									
	4	55.64	2.37	0.36*	60.67	2.18	0.11	16.17	3,227	**.001**	.131	1,109	.72	2.80	3,227	**.04**
CDI-S	1	50.14	.881		51.83	.892										
(n=367)	2	49.87	.885	0.02	51.53	.885	0.03									
	3	49.66	.888	0.02	51.03	.886	0.04									
	4	48.53	.944	0.09	50.75	.947	0.02	1.22	3,901	.30	2.66	1,388	.10	.247	3,901	.86
Clinical	1	72.89	2.27		69.85	2.06										
(n=62)	2	67.69	2.37	0.42	67.29	2.19	0.20									
	3	64.97	2.39	0.22	67.00	2.17	0.02									
	4	62.70	2.63	0.16	61.72	2.49	0.36	5.50	3,150	**.001**	.073	1,76	.79	.586	3,150	.63

Note.CBM-I = Cognitive Bias Modification-Interpretation; *d* = Cohen's *d* (within-group mean difference); BAI-Y = Beck Anxiety Inventory-youth; CDI-S = Child Depression Inventory- Short form; Anxiety and Depression clinical T-score ≥ 60; Fixed effects $p < .05$ is in bold; Within-group mean difference; ***$p < .001$; **$p < .01$; *$p < .05$

Table 5. Model estimates, within group effect sizes and type 3 fixed effects of time, group and group by time on the Test of Interpretive Bias negative/threat related and positive bias scales.

		Model estimates and effect sizes						Type III fixed effects								
		CBM-I			Controls			Time			Group			Group × time		
Measure	Time	*M*	*SE*	*d*	*M*	*SE*	*d*	*F*	*dfs*	*p*	*F*	*dfs*	*p*	*F*	*dfs*	*p*
TIB negative	1	28.06	.789		29.92	.793										
(n=369)	2	26.23	.794	0.17	29.66	.792	0.02									
	3	25.32	.795	0.08	27.78	.790	0.18									
	4	25.61	.848	0.03	28.59	.846	0.07	7.02	3,908	**.000**	8.02	1,388	**.005**	1.54	3,908	.20
Clinical	1	42.33	1.38		43.22	1.23										
(n=81)	2	35.58	1.44	0.78	39.24	1.27	0.47									
	3	31.20	1.44	0.51	37.46	1.27	0.21									
	4	32.66	1.63	0.15	35.68	1.38	0.19	22.94	3,196	**.000**	5.52	1,91	**.02**	2.47	3,196	.06
TIB Positive	1	48.48	.654		47.81	.658										
(n=369)	2	49.73	.660	0.14	48.53	.658	0.08									
	3	50.44	.660	0.08	48.58	.654	0.01									
	4	50.53	.709	0.01	49.42	.708	0.09	3.95	3,913	**.008**	2.53	1,399	.11	.664	3,913	.57
Clinical	1	38.44	1.15		38.08	1.05										
(n=90)	2	42.46	1.22	0.52	41.69	1.08	0.48									
	3	43.75	1.24	0.16	41.21	1.07	0.06									
	4	43.98	1.35	0.03	43.45	1.22	0.26	10.41	3,223	**.000**	.841	1,108	.36	.645	3,223	.59

Note. CBM-I = Cognitive Bias Modification- Interpretation; *d* = Cohen's *d* (within-group mean difference); TIB = Test of Interpretive Bias – negative and positive scale; Negative clinical ≥75th percentile; Positive clinical ≤ 25th percentile; Fixed effects $p < .05$ is in bold; Within-group mean difference.

Table 6. Model estimates, within group effect sizes and type 3 fixed effects of time, group and group by time on the Ambiguous Situations Test measure of negative and positive social interpretive bias.

		Model estimates and effect sizes						Type III fixed effects								
		CBM-I			Controls			Time			Group			Group × time		
Measure	Time	*M*	*SE*	*d*	*M*	*SE*	*d*	*F*	*dfs*	*p*	*F*	*dfs*	*p*	*F*	*dfs*	*p*
AST negative	1	40.09	.889		42.06	.901										
(n=369)	2	37.75	.900	0.19***	42.07	.897	0.00									
	3	37.99	.901	0.02	40.86	.895	0.10									
	4	38.01	.963	0.00	41.68	.959	0.06	2.83	3,908	**.04**	8.88	1,390	**.003**	2.72	3,908	**.04**
Clinical	1	55.08	1.39		55.68	1.22										
(n=85)	2	48.14	1.46	0.78	52.81	1.26	0.33									
	3	47.23	1.51	0.10	49.85	1.27	0.34									
	4	49.60	1.80	0.22	50.64	1.42	0.08	12.72	3,198	**.000**	2.54	1,96	.114	1.67	3,198	.176
AST-positive	1	55.87	.738		55.59	.750										
(n =369)	2	58.80	.749	0.29	56.19	.746	0.06									
	3	58.80	.750	0.00	56.47	.744	0.03									
	4	58.98	.811	0.02	57.15	.807	0.06	6.50	3,909	**.000**	4.26	1,400	**.04**	2.37	3,909	.07
Clinical	1	45.23	1.15		45.28	1.10										
(n=90)	2	51.83	1.22	0.83	48.02	1.14	0.35									
	3	51.57	1.19	0.03	49.36	1.15	0.17									
	4	51.35	1.41	0.02	50.17	1.32	0.09	12.00	3,223	**.000**	2.53	1,115	.115	1.59	3,223	.193

Note. CBM-I = Cognitive Bias Modification-Interpretation; *d* = Cohen's *d* (within-group mean difference); AST = Ambiguous Situations Test -negative and positive scale; Negative clinical $\geq 75^{th}$ percentile; Positive clinical $\leq 25^{th}$ percentile; Fixed effects $p < .05$ is in bold; Within-group mean difference; $^{***}p < .001$

Table 8.

Proportion of CBM-I and control participants who were at risk (i.e., had high negative bias) who did and did not move to the clinical range at 12- and 24-week follow-up on outcome measures of trauma, maladaptive cognition, anxiety and depression

		Status at 12 weeks follow up		Status at 24 weeks follow up	
Variable	Group	Normal range (*n*, %)	Clinical range (*n*, %)	Normal range (*n*, %)	Clinical range (*n*, %)
Trauma					
(CPSS)	Intervention	5 (83)	1 (17)	3 (75)	1 (25)
	Control	4 (50)	4 (50)	4 (57)	3 (43)
Cognition					
(cPTCI)	Intervention	9 (81.8)	2 (18.2)	5 (71.4)	2 (28.6)
	Control	11 (91.7)	1 (8.3)	8 (80)	2 (20)
Anxiety					
(BAI-Y)	Intervention	16 (100)	0 (0)	10 (83.3)	2 (16.7)
	Control	18 (90)	2 (10)	13 (86.7)	2 (13.3)
Depression					
(CDI-S)	Intervention	16 (88.9)	2 (11.1)	11 (91.7)	1 (8.3)
	Control	15 (78.9)	4 (21.1)	14 (82.4)	3 (17.6)

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory for youth; CDI-S = Children’s Depression Inventory – Short Form.

Table 7. Model estimates, within group effect sizes and Type 3 fixed effects of time, group and group by time for mood before and after training sessions.

		Model estimates and effect sizes						Type III fixed effects								
		Positive CBM-I			Controls			Time			Group			Group × time		
Training Session		*M*	*SD*	*d*	*M*	*SD*	*d*	*F*	*dfs*	*p*	*F*	*dfs*	*p*	*F*	*dfs*	*p*
Training 1	Pre	4.02	.81		3.98	.89										
	post	4.22	.86	0.17	4.03	.92	0.04	10.72	1,355	**.001**	1.84	1,355	.18	3.86	1,355	**.05**
Training 2	pre	3.99	.93		4.01	.92										
	post	4.20	.91	0.16	4.01	.97	0.00	5.59	1,357	**.01**	1.04	1,357	.31	5.02	1,357	**.02**
Training 3	pre	3.97	1.03		3.92	1.02										
	post	4.13	1.02	0.11	3.95	1.01	0.02	4.15	1,354	**.04**	1.41	1,353	.24	1.73	1,354	.18
Training 4	pre	4.02	1.06		3.94	1.04										
	post	4.14	.98	0.08	3.89	1.10	0.03	.50	1,346	.48	2.72	1,346	.10	2.73	1,346	.09

Note. CBM-I = Cognitive Bias Modification-Interpretation; *d* = Cohen's *d* (within-group mean difference); Fixed effect *p* <.05 is in bold.

Discussion

The aim of the study was to assess the efficacy of a brief CBM-I intervention to modify interpretive biases and trauma symptoms for a nonclinical child sample. Specifically, I investigated whether four training sessions could modify children's negative interpretation biases and strengthen an adaptive interpretive style to facilitate a reduction in trauma symptoms.

Moderate correlations were observed between measures of interpretive bias and the outcome variables. Contrary to expectation, and with one exception (i.e., anxiety as measured by the BAI-Y), I did not find any effect of the intervention relative to controls when the entire sample was considered. However, this was not completely unexpected as a large proportion of the sample was within the normal range of functioning. Excluding the anxiety outcome, analyses on the subset of individuals in the clinical range at baseline similarly demonstrated no differential effects of the intervention. I did not find any moderator effects for gender on the outcome variables (e.g., trauma, maladaptive cognition, anxiety and depression). Age was found to moderate older children's reduction of anxiety in the whole-sample analyses but had no effect on the remaining symptom measures. Gender was found to moderate children's reductions of negative interpretation bias when processing social ambiguity. I observed mixed results of the intervention across the interpretive bias measures. On the one hand there was no impact on positive interpretive biases as measured by the Test of Interpretive Bias (TIB) or the Ambiguous Situations Test (AST), although a trend was observed for ambiguous social biases. Again, this was not surprising given the children's pre-existing tendency toward benign interpretations at baseline. On the other hand, I did find an intervention effect when analysing the entire sample for negative interpretation biases, associated with social situations (as measured by the AST). However, I found no effect of the intervention when analysing the subset of those with higher level of negative threat-related interpretative bias, although the

TIB negative scale just fell short of significance. I found an intervention effect on children's mood (i.e., happiness level) after training, but the size of the effect was small. Finally, my data afforded the opportunity to assess whether there was a preventative effect of the intervention (i.e., for individuals with a high level of negative interpretive bias but not currently showing symptoms). However, I found no evidence the intervention could reduce children's level of future risk. Where this fits within the current literature and explanations for null findings are now discussed.

My finding that negative threat-related interpretive biases were correlated at baseline with trauma, maladaptive cognition and mood symptoms is consistent with the majority of prior research with child/youth anxiety (Cox et al., 2015; Muris & Field, 2013; Muris et al., 2009; Salemink & Wiers, 2011), depression (Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2017) and PTSD (Ehlers et al., 2003), although exceptions exist (e.g., de Voogd et al., 2018). The authors of this last study suggested a possible methodological explanation for this discrepancy - administering the interpretation bias assessment in group format may have influenced participants' concentration and performance leading to an inaccurate assessment of existing biases.

Results from the *whole sample* analyses showed that the intervention group, relative to the controls, endorsed significantly fewer negative interpretations of social ambiguity on the AST, a measure that is completely focused on social situations. This replicates the work of others, although this has largely come from the same research team (Vassilopoulos et al., 2009; Vassilopoulos, Blackwell, et al., 2012; Vassilopoulos & Brouzos, 2016; Vassilopoulos, Brouzos, et al., 2015; Vassilopoulos, Moberly, et al., 2012) but see Chan et al. (2015) for a null finding. However, CBM-I did not result in significant change in participants' level of *positive* social interpretations on the AST, nor negative *or* positive threat-related interpretation biases as indexed by the TIB. Beyond the fact that the sample as a whole was unselected, another explanation for the null finding concerns the training dose, given children received only four sessions (total of 80 trials) in close succession. Although this dose appears enough to alter negative social interpretations, repeated training sessions over a longer period may be necessary to facilitate a change in children's negative threat-related interpretation bias associated with trauma exposure. Further, the lack of change in children's level of positive interpretation biases following training is suggestive of a ceiling effect previously observed with unselected community samples (Lester et al., 2011a).

Contrary to predictions, the intervention did not result in change in trauma-related (CPSS, cPTCI) nor depression symptoms (CDI-S) for the sample overall. With respect to trauma symptoms and cognitions, these findings contrast with adult studies that have shown reduction in bias appraisals with positive CBM (Woud et al., 2018; 2012; 2013). Notwithstanding any developmental differences, these studies used an analogue trauma induction (i.e., stressful film), designed to standardise 'trauma' exposure and enable assessment of immediate intrusions, arousal and distress. In contrast, children in the present study reported on PTS reactions to personally experienced events and, of those who cited the same event across all assessments, approximately 20% were Criteria A events capable of causing PTSD (APA, 2013). Although one might expect it more likely that CBM-I have an impact on those who had experienced real trauma, many of the children reported low levels of PTS. The positive findings with adults to date might also have capitalised on the short-term effects of an acute stressor. The examination of CBM-I with children experiencing PTSD may shed further light on these questions. Alternatively, the rationale underpinning CBM-I methods is that that cognitive biases are implicated in the aetiology and maintenance of emotional disorders like anxiety and PTS. Investigation of CBM studies have shown support for the model only when the training resulted in a change in cognitive bias which then reduced emotional vulnerability / symptoms (Clarke, Notebaert, & MacLeod, 2014;

Grafton et al., 2017). Thus, it is perhaps not unsurprising that as the current CBM training did not alter children's level of negative interpretation bias, a change in trauma symptoms was not observed.

Depression levels remained stable across the sample, and like other studies, this was also seen in the clinical subset where reductions were not observed as a result of the intervention (LeMoult et al., 2017; Micco et al., 2014). In the present sample this may be due to the training items not specifically targeting depression-like cognitions.

Further analyses with the subsample of children already showing clinically significant biases (i.e., children with high negative interpretive bias) did not reveal any treatment effect (albeit a non-significant trend for threat-related interpretation bias among CBM-I participants). This is consistent with earlier bias modification work (Muris et al., 2009) but at odds with Klein et al. (2015) and others who have shown superior CBM-I treatment effect for individuals with pronounced negative interpretation bias (Lau et al., 2013; Muris et al., 2008; Orchard et al., 2017; Salemink & Wiers, 2011; Vassilopoulos et al., 2009). The result may reflect differences between individuals selected from a community population, versus those with a psychiatric disorder. Other considerations concern the training dose, for example, children in Klein's clinical sample received 40% more training relative to that delivered in the current study. In addition, post-training improvement for children with low levels of positive interpretation bias (on the TIB-trauma-related threat biases and AST-social biases measures) was observed across groups.

The treatment effects observed for participants above the cut-off on the anxiety measure support previous investigations (Klein et al., 2015; Lau et al., 2013; Muris et al., 2008; Vassilopoulos et al., 2009; Vassilopoulos, Blackwell, et al., 2012), but contrast with other studies using clinical populations (Fu et al., 2013; Orchard et al., 2017; White et al., 2016). Accounting for discrepancy in findings is challenging, with factors such as initial bias severity, varying measures, and treatment dose all possible relevant factors.

As previously noted, my data provides *some* evidence that CBM-I modified negative biases associated with social ambiguity and showed a non-significant trend among CBM-I participants with high levels of negative threat-related biases. Although the change in CBM-I positive interpretation biases was not significantly different from controls, the observed effect sizes for negative and positive interpretation biases are consistent with meta-analyses showing CBM-I works better than control (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017). Further, given the adequate sample size for analyses using the *entire* sample in the current study, the null findings cannot be attributed to a lack of power. Baseline data indicated that the majority of participants had a pre-existing positive bias when interpreting ambiguity which may have left little room for further improvement. Nonetheless the study's longer follow up assessment of modified interpretation biases (i.e., up to 24 weeks) extends previous findings that have documented bias changes lasting up to 24 hours (Belli & Lau, 2014), 3 days (Vassilopoulos et al., 2009) and to one week (Chan et al., 2015).

The shift in positive and negative interpretation biases for both the intervention and control participants was unexpected but have been reported in numerous unselected studies with neutral controls (Belli & Lau, 2014; Chan et al., 2015; de Voogd et al., 2018; Fu et al., 2015) as well as clinical investigations (Fu et al., 2013; Orchard et al., 2017). Explanations for why this may have occurred include: the positive effect of the placebo training, a lack of experimental control (i.e., task compliance in online training) and lack of difference between the CBM-I and neutral training items (i.e., ½ positive ½ negative items) that may have been sufficient enough to alter control participants' interpretation style. Although some methodological differences may account for why control children in some studies have demonstrated bias change (e.g., Chan et al., 2015), control groups are not always completely inert, and can result in expectancy effects that influence subsequent cognitive and emotional processing (Blackwell et al., 2017). In addition, natural change and maturation effects cannot be excluded (Berk, 2009). The use of a ‘no training’ control in future research would assist in dissecting these factors.

Some anecdotal observations of children’s performance offer additional explanations for some of the findings. Participants were required to select an interpretive response and were given feedback on their answer (i.e., ‘you are correct/incorrect’ intervention participants received expanded feedback). This ‘active’ method is considered necessary for effective CBM-I training (Hoppitt, Mathews, Yiend, & Mackintosh, 2010). However, some children in both groups signalled frustration at not being able to make their own interpretive choice and, in some cases, appeared apathetic and/or ignored the designated option. It remains unclear to what extent this may have influenced results, however the inclusion of an open-ended response (i.e., How might you interpret this situation?) might address this issue and is now recommended best practice (Schoth & Liossi, 2017). Further, significant efforts were made to minimise the degree to which participants interacted with one another during the training in order to reduce controls from realising differences in their training relative to the intervention children. However, this might not have been fully achieved, and informed consent procedures did mean children were aware the study involved examining thinking patterns or styles. The latter may have impacted on expectancies in the control group as highlighted earlier. Administering the training conditions on different days, or times, may help improve the fidelity of the intervention, although it does present logistical challenges.

Although the intervention generally had limited effect, it was of interest that change was observed in general anxiety, not trauma symptoms. This might be due to the relevance of the scenarios used and specific interpretations that were being modified. Klein et al.’s (2015) identification of content specificity effects (i.e., bias and symptom changed only for social threat scenarios and not threat or non-threat scenarios, across anxiety disorders) support this proposal (see also Stuijfzand et al., 2017) as well as the suggestion that induced biases with CBM-I procedures maybe domain specific (Mackintosh, Mathews, Yiend, Ridgeway & Cook, 2006). As discussed in Chapter 2, the content of the training scenarios and items for the TIB was based upon themes relevant to trauma concerns identified in both the empirical and theoretical child PTSD literature (i.e., exaggerated fears, vulnerability, mistrust, permanent change; Meiser-Stedman, 2002; Meiser-Stedman, Smith, et al., 2009). These scenarios therefore were designed to incorporate ambiguity and a perception of threat in everyday situations without triggering distress for the recipient. The content was systematically reviewed by psychology researchers within the field and, piloted with a group of unselected children. Further, it was necessary to create scenarios that encompassed the specificity required to modify trauma-related appraisals, whilst balancing the needs of the individual and ethical considerations. Despite the attempt to make these processes trauma-relevant, the latter factors may have resulted in a training approach and interpretative bias measure (the TIB) that may have been more relatable for children with general anxiety rather than trauma-specific concerns and symptoms. Indeed, the observed training effect on the AST measure rather than the TIB are consistent with research that has shown transfer of training effects only when the content of the training and test descriptions were matched (Mackintosh et al., 2006).

In addition, if the scenarios were more relevant to general anxiety, it may have been more challenging for children with PTS symptoms to imagine themselves in the example situation, despite being encouraged to do so. The notion of self-referential processing is in keeping with this idea and suggests that how well an individual relates to a situation, or recalls information, is somewhat dependent upon whether the event or information has personal relevance as opposed to material that has less personal meaning (Roediger III & Pyc, 2012).

Despite the suggestion that CBM-I may be influenced by age and/or gender (Lau & Pile, 2015) I found mostly no evidence of these moderator effects upon the trauma-related or mood outcome variables, which is consistent with recent meta-analyses (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017). Age was shown to moderate the effect of CBM-I training for children's anxiety symptoms with the full sample. I found the rate of change in anxiety for younger children across groups was comparable overtime. In contrast older children in the CBM-I group reported a significant reduction in anxiety between pre to post assessment whereas the control condition showed a non-significant increase in anxiety over this period. Further, a three-way interaction was observed for children with a clinical level of negative interpretive biases (AST- social interpretive biases) which appeared to be driven by differential patterns of change between pre- and post-training. Thus, regardless of condition, males showed a significant reduction in bias. In contrast, only females in the intervention group reduced their negative interpretive bias in the same interval, with the control group remaining unchanged. Although this single result is consistent with age effects observed in Lau and Pile's (2015) study, it should be noted that the *older* children (11-13 years) in the current study were much younger than the adolescents used in their investigations (11-18 years) and therefore may not be directly comparable. Moreover, these significant findings should be interpreted in the context of the large number of null findings, and caution exercised before over-interpretation of a single finding. Clearly replication and further exploration is required.

As with previous CBM-I research I also examined the influence of training on participants' mood before and after the training sessions. In line with some research (Lothmann et al., 2011) and discrepant with others (Chan et al., 2015), the analyses indicated an interaction effect (i.e., Training set 1, p =.05; Training set 2, p =.02), where CBM-I participants' mood significantly improved post training relative to controls. Although these results were unable to show if better mood enhanced children's learning capacity and training outcome, the shift in mood, albeit small (i.e., d = 0.17 to 0.08), was detected across the four training sets.

Finally, I was interested in the potential preventive effect of CBM-I, however this was not observed. Thus, when those who exhibited high negative interpretive bias and low symptoms at baseline were followed-up, the proportion of children whose scores now placed them above the clinical cut-off for the respective measure (CPSS, CDI-S, TIB etc.) was comparable across groups. For outcome as measured with the CPSS, low power likely contributed to this, and may still have impacted analyses on other measures. That said, results from these underpowered analyses cannot be reliability interpreted. Of course, the lack of intervention effects overall indicates perhaps there is no preventative impact of the training or that a higher dose is required to see preventive or sleeper effects.

The study had several strengths. To my knowledge, it was the first to examine the effect of positive CBM-I on trauma-related interpretive biases and symptoms in an unselected child population. The use of 3- and 6-month follow-up was enough interval to allow adequate assessment of the maintenance of intervention effects (had they occurred) and enabled the detection of any delayed effects of the training. Very few studies have involved such follow-ups which have important implications for the utility of CBM for community and clinical populations. In addition, the longitudinal design allowed for the testing of the CBM-I as a preventative intervention. Although this was not observed in this case, on addressing some of the limitations of the current study, there remains the possibility that the intervention could prove useful as a preventative approach for child populations who may be risk (i.e., those with subclinical symptoms of PTSD). The good sample size, inclusion of a control comparison, and moderator analyses were further strengths. The use of multimedia (i.e., text, images and audio) in the training scenarios had dual benefits. First, to reduce cognitive demand on one processing modality, and second, to promote children's deeper learning by strengthening the connectivity between verbal and visual representation of the same material (Mayer, 2008). If delivered with a greater dose, it is possible these elements might help the intervention become more potent. Finally, my adaptation of Mathews and Mackintosh's (2000) training protocol to frame trauma related concepts within the scenarios and include cognitive restructuring statements at the final step of each scenario was unique to this study.

In addition to those already mentioned, I acknowledge several limitations. The use of a subsample of participants for the CPSS analyses (i.e., using only participants who reported the same trauma events at each assessment) limited the interpretation of results with the reduced sample size being underpowered. My results were also solely based upon self-report measures of interpretive bias, trauma related and mood symptoms which are subject to demand characteristics and memory bias (MacLeod et al., 2009). Further, I cannot rule out practice training effects, whereby children may have learnt to provide the 'expected' answer. Thus, the failure to include dummy trials that involve neutral filler scenarios (i.e., ending with factual interpretations) to mask the obviousness of the task's purpose may have contributed to expectancy effects (Schoth & Liossi, 2017). That said, there is some concern filler trials may dilute the positive training effect (Micco et al., 2014). Participants guessing the training aim has been noted in other research (Chan et al., 2015). The repetitive format of the training trials whilst unavoidable may also increase the likelihood children will recognise the purpose of the study (or disengage). Outcomes were based solely on child report - children and parents' reporting accuracy of the child's psychological symptoms can differ following CBM-I (Klein et al., 2015). Thus, inclusion of significant other informants (i.e., parent and/or teacher) would be informative. Although the composition of the sample was varied with children from different socio-economic backgrounds, geographic locations and school characteristics, nonetheless, and consistent with the demographics of the study locations, most were White which limits the generalisability of findings to other races/ethnicities. Further, there was a difference between the opt-in/out groups in baseline anxiety and positive biases associated with social ambiguity, with opt-out participants doing less well than their counterparts on both measures. This difference however was observed for just 2 of the 12 baseline variables and in both cases the opt-out participants scores were still within the normal range of functioning and the effect size was small. Similarly, the opt-in/out recruitment methods also influenced the proportion of participants drawn from public/private schools and the schools' geographical location (i.e., metropolitan vs. regional). However, this circumstance was unavoidable due to the location of the type of school. Overall it is unlikely the opt-in/out recruitment method was a major source of bias. I also acknowledge that the study involved a number of statistical tests which could lead to excessive Type one error. Notwithstanding this potential issue, the findings have been interpreted considering not only statistical significance but also as magnitude of effect sizes.

In terms of other methodological improvements for future research, the effects of training may have been further enhanced with interleaved learning. Learning two or more related concepts simultaneously and alternating between them has been shown to lead to higher learning gains partly because it increases retention of the material learnt (Roediger III & Pyc, 2012). Thus, the inclusion of a creative task within a trial, one that embodies the training objective (e.g., a small 'find a word' exercise or crossword using the key intervention terms as the subject matter), may improve attention, limit acquiesce responses and stimulate learning pathways which may assist with the generalisation of the training. From a design perspective, future work might also incorporate a more targeted approach to improve the personal relevance of the training trials. For example, embedding the child's name for the central character within the scenario together with more relatable situations that are typical following a stressful and/or traumatic event (i.e., recovery, sleep disturbance, controllability, dealing with unexpected situations, and managing change). The personalisation and incorporation of more trauma related content maybe important to differentiate this version of CBM-I, from others in existence (i.e., targeting social anxiety) and improve a CBM-I intervention capable of modifying trauma-specific interpretation bias. Furthermore, obtaining information from significant other informants about the child's stressful experience may increase self-referential processing and improved generalisation of the training task.

In sum, research addressing trauma symptoms with CBM-I is relatively new, with only a handful of adult studies conducted to-date. This investigation examined the efficacy of the intervention designed to alter threat-related negative interpretation bias and trauma symptoms in a sample of unselected children. To some degree the data showed CBM-I can lead to an adaptive change in children's negative and positive interpretation biases, but this did not translate to change in children's actual trauma-related symptoms. My data however provides an informative starting point to further extend these investigations into clinical samples. The following chapter details whether CBM-I can be used effectively with children with clinical levels of PTS following accidental injury.

CHAPTER 4

Study 3

A child's exposure to a traumatic event can lead PTSD (Fairbank & Fairbank, 2009). Characterised by clusters of varying symptom types (i.e., re-experiencing; hyper-arousal; avoidance; and negative alteration in cognition and mood), PTSD can cause clinically significant distress and functional impairment (American Psychiatric Association [APA], 2013). Children with PTSD may also experience behavioural and neurobiological disturbances and psychiatric comorbidity (Dyregrov & Yule, 2006). These problems may compound the individual's immediate and future suffering, and place additional burden upon the health sector (Rosenberg et al., 2000). Although many children recover naturally following trauma exposure (Copeland et al., 2007; McGuire, 2016), a significant minority experience PTSD. Current figures are estimated at approximately 16% (Alisic et al., 2014). According to prevailing cognitive models of PTSD (Ehlers & Clark, 2000; Meiser-Stedman, 2002), modifying maladaptive appraisals that occur following traumatic event(s) is critical in order to improve coping and attenuate PTSD symptoms.

Recommended evidence-based treatments for the treatment of childhood PTSD (e.g., Trauma-Focused Cognitive Behavioural Therapy, TF-CBT) stress the importance of appraisal modification and have received strong support across several meta-analysis studies (Butler, Chapman, Forman, & Beck, 2006; Cary & McMillen, 2012; Gillies, Taylor, Gray, O'Brien, & D'Abrew, 2013; Roberts, Kitchiner, Kenardy, & Bisson, 2009). Yet not all children with trauma symptoms have the resources to engage with specialist therapy services, such as; access to trained professionals;-, parental support;-, financial and transportation means, nor do all experience symptomatic relief following CBT interventions (Cohen, Berliner, et al., 2000; Damian, Gallo, & Mendelson, 2018; Stallard, 2006). Further, the use of pharmacotherapy for childhood PTSD is not recommended (Smith, Dalgleish, & Meiser-

Stedman, 2018). This gap in service provision highlights a need for new approaches to treatment delivery. Therefore, the aim of the present study is to examine the efficacy of Cognitive Bias Modification of Interpretations (CBM-I) to modify trauma-related interpretive biases and to promote symptom reduction in a clinical child sample with posttraumatic stress.

A major component of Ehlers and Clark's (2000) cognitive model, first developed to explain PTSD in adults, is based upon the premise that maladaptive trauma-related appraisals elicit a sense of current threat which generates fear and leads to maladaptive coping like cognitive or behavioural avoidance. These responses act as a barrier to cognitive change and impede recovery. Ehlers and Clark's model therefore provides a framework of understanding the underlying mechanisms of PTSD and the relevance of cognitive based treatment interventions (Dalgleish, 2004). Although it should not be assumed that Ehlers and Clark's theory can be automatically applied as an explanation of PTSD in children, as the manifestation of the disorder may differ from that of adults (APA, 2013), a significant body of research now demonstrates its applicability to this population. Relevant to the current study, the role of children's trauma-related cognitions following trauma exposure in accounting for PTSD symptoms, has been substantiated by a large body of work over the past decade (e.g., Bryant et al., 2007; Ehlers et al., 2003; Hiller et al., 2015; Leeson & Nixon, 2011; Meiser-Stedman, Dalgleish, et al., 2009; Nixon, Nehmy, et al., 2010; Salmon et al., 2007). Collectively, these studies have shown that for children and adolescents who have experienced a range of traumatic events (i.e., maltreatment, accidental injury, physical assault), higher levels of unhelpful trauma-related appraisals accounted for both the initial onset and maintenance of posttraumatic distress over time, in line with cognitive theory (Dalgleish, 2004; Ehlers & Clark, 2000; Meiser-Stedman, 2002). A recent randomised controlled trial investigating the efficacy cognitive therapy as an early intervention for children with PTSD, found treatment effects were mediated through changes in dysfunctional appraisals and safety seeking behaviours (Meiser-Stedman, et al., 2017).

Appraisal biases associated with child PTSD tend to be unrealistic and negative. They can centre on concerns about the trauma or its aftermath and can relate to internal intrusive trauma-related memories, physiologic arousal, and/or external (i.e., exposure to trauma-related environment) stimuli (Ehlers et al., 2003). Specific trauma-related appraisals exhibited by children with PTSD have been well researched and typically reflect themes related to a sense of permanent change following trauma, unrealistic exaggerated fears and perceptions of vulnerability, and concerns regarding the danger of the world around them (Meiser-Stedman, Smith, et al., 2009; Nixon, Nehmy, et al., 2010; Stallard, 2003). These biases, or thinking style, therefore may help explain why negative interpretations are made when children with posttraumatic stress encounter ambiguous situations or scenarios. Although this proposition has not been directly assessed with childhood PTSD, unhelpful appraisals in PTSD are not too dissimilar from threat perceptions identified in general childhood anxiety. Therefore, it may be helpful to draw upon the findings of non-trauma research that have examined ambiguous situations and dysfunctional processing biases to demonstrate this point.

Britton, Lissek, Grillon, Norcross and Pine's (2011) review of the interplay of attention, threat-appraisals and fear learning on anxiety outcomes, suggested that threat appraisal biases and fear responses in anxious disorders reflect an overgeneralisation of learning and an incapacity to separate safe and threatening stimuli and inhibit fear reactions in neutral or safe situations. Muris, Rapee, Meesters, Schouten and Geers' (2003) study of perception abnormalities in children demonstrated that threat-perceptions associated with ambiguity accounted for a unique proportion of variance in anxiety. Specifically children with higher level of anxiety, when confronted with ambiguous stories, gradually unfolding sentence by sentence, had lower threat threshold (i.e., less information was needed before perceiving threat) and higher frequency of threat perception, concluded threat outcome sooner in the story than those low in anxiety (Muris et al., 2003). Both investigations highlight the relationship between a bias cognitive style and automatic negative processing of ambiguous situations. Consequently, as the aim of CBM-I has been to modify an interpretive bias style associated and anxiety, its use to address threat-related biases associated with childhood PTSD has strong potential.

CBM-I is a computerised intervention where individuals are repeatedly presented with ambiguous scenarios and systematically trained to adopt an interpretation response in accordance with the desired orientation like benign, negative or neutral interpretation (MacLeod et al., 2009). The seminal work in adult populations with varying levels of anxiety (e.g., studies 4 and 5) (Grey & Mathews, 2000; Mathews & Mackintosh, 2000)) demonstrated that this approach led to a change in anxiety symptoms. Consequently CBM-I has been widely investigated with unselected and clinical child/youth populations. Thus meta-analytic studies show support for the influence that CBM–I can have in altering both negative and positive interpretation biases for young people (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017), although its effect upon *symptoms* has been reported as less robust compared to that seen in adult samples (Hallion & Ruscio, 2011; Jones & Sharpe, 2017).

As reviewed in earlier chapters, the effects of CBM-I on children's interpretive biases and symptoms have been demonstrated with respect to childhood anxiety (see Chapters 1 and 2). Summarising from these earlier chapters, the initial proof of principle CBM-I research was conducted with unselected samples and demonstrated change in children's positive and negative interpretations following training (Lester et al., 2011b; Muris et al., 2008; Muris et al., 2009), and in some cases, resulted in changes in anxiety (Lau et al., 2013; Vassilopoulos et al., 2009; Vassilopoulos, Blackwell, et al., 2012), although this is not a universal finding (see Chan et al., 2015; Fu et al., 2013; Vassilopoulos, Moberly, et al., 2012). As briefly discussed below the potential effectiveness of CBM-I within clinical samples has also been investigated (a more comprehensive review was reported in Chapter 3).

Researchers to date have used CBM-I to train positive/benign interpretations in child/youth clinical populations with a focus upon those with anxiety and depressive disorders. The effectiveness of CBM-I to improve positive interpretation bias in such samples has been demonstrated across studies employing varying methodology and settings (i.e., school vs. laboratory, online vs. virtual, varied number of training sessions) (Chan et al., 2015; de Voogd et al., 2018; Fu et al., 2013; LeMoult et al., 2017; Micco et al., 2014; Salemink & Wiers, 2011). These training effects however did not translate to significant reductions in symptoms, and in the one instance when change was observed, both the intervention and placebo group showed similar rates of decline in anxiety and depressive symptoms (de Voogd et al., 2018). Similarly, CBM-I research with children at risk for anxiety showed an adaptive change in positive interpretation bias following training, but no reduction in anxiety symptoms (White et al., 2016). Moreover, no treatment effect for symptoms was observed in another study involving children with social anxiety (Orchard et al., 2017). In both White et al. and Orchard et al., training dose was relatively modest (i.e., 1-3 sessions) and was suggested as a reason for the null findings. In contrast, other clinical research has shown adaptive bias change and reduction in anxiety symptoms following positive CBM-I training.

For example, Reuland and Teachman (2014) examined the effect of eight online sessions of CBM-I training involving parents with children with social anxiety aged 10-15 years. The inclusion of parents was based on the premise that parents of children with social anxiety may model anxiety by conveying their own cognitive biases like, overestimation of threat and social avoidance, which leads to intrusive parenting practices (i.e., providing unnecessary assistance, invasion of privacy, infantilising, use of baby talk) (see McLeod, Wood, & Avny, 2011). These unhelpful interactions are thought to encourage children's biases and social anxiety symptoms. The sample consisted of mother–child dyads (N = 18). Participants were randomised to: child only condition – targeting children's biases associated with social anxiety (n = 7), parent-only condition - targeting parents biases linked with intrusive behaviours (n=5), and a parent-youth combination condition - targeting both youth and parent cognitive biases (n= 6). One participant from the child-only condition was excluded from analyses. No parent from the parent-only condition showed significant reduction in biases associated with intrusive behaviour following treatment although three children (from the parent-child and child-only conditions) demonstrated symptom improvement immediately after training, with approximately one third of the entire sample, across all conditions (i.e., n = 6) reporting clinically significant change. Although these outcomes might be considered somewhat unimpressive and need to be qualified by the modest sample size, as highlighted by the authors, the treatment response rate (35%) was comparable with the response rates observed following traditional CBT for child anxiety.

In another study with clinically anxious children (i.e., 7-11 years), only individuals with elevated negative bias prior to training reported a reduction in bias interpretation associated with social threat scenarios following CBM-I (Klein et al., 2015). Parents of intervention children, but not the children themselves, reported a decline in children's social anxiety following positive training.

In summary, several studies show malleability in children's interpretive bias style following CBM-I training. Although the change in interpretation bias and its effect on children's anxiety symptoms is not universal, these clinical investigations suggest CBM-I may be a feasible intervention for children experiencing other psychiatric disorders such as PTSD where cognitive interpretation biases play a central role in the aetiology and maintenance of the disorder. To my knowledge CBM-I has not been investigated for children experiencing PTSD. However, there are three studies to date within the adult PTSD literature that have used the CBM method to foster an adaptive appraisal style in the context of analogue trauma exposure, that is, within the trauma film paradigm (Woud et al., 2018; Woud et al., 2012; Woud et al., 2013). Results across these studies suggest positively trained individuals experienced a reduction in trauma-related appraisals and symptom improvement. Whether similar findings would be observed in children with clinical levels of symptoms remains an empirical question.

Aside from a small number of clinical studies, the bulk of CBM-I research to date with children and youth has been conducted with unselected community populations (Lau, 2013). This research is an important first step in determining any benefit of an intervention. However, drawing subgroups for assessment from within non-clinical sample populations may result in a small number of participants with the desired criteria therefore making analysing the data more difficult. Moreover, meaningful information from subgroups analyses is somewhat dependent upon statistical power of the study to detect meaningful differences should they exist (Cook, Gebski, & Keech, 2004). The current study was designed to address several gaps in the child trauma field. First, the recruitment of clinically symptomatic children with probable PTSD was undertaken to maximise the likelihood of observing effects (Klein et al., 2015). Second, the assessment of threat-related interpretation biases change following CBM-I allows theoretical advancement by increasing our understanding of the mechanisms of childhood PTSD. Finally, my evaluation of CBM-I for children experiencing PTSD extends the current literature beyond that conducted in children with general and social anxiety, and importantly, tests the clinical utility of this intervention, an issue which is currently under debate (see Cristea, Mogoașe, et al., 2015; Krebs et al., 2017).

In sum, the effectiveness of positive CBM-I training was examined in children who had experienced a single event trauma (i.e., accidental injury that required hospitalisation) and who had probable PTSD assessed 4 to 6 weeks post injury. This cohort was chosen as children are at risk of experiencing PTSD following accidental injury (Kenardy, Spence, & Macleod, 2006; Meiser-Stedman et al., 2005). Further, the timing of intervention presented a unique opportunity to capture the effects of positive CBM-I early in the disorder's trajectory. I predicted that following positive CBM-I training children would report a reduction in their levels of threat-related interpretation bias and post-trauma and related symptoms compared with waitlist controls.

Method

Participants

Seventeen children were recruited from the surgical and general wards of the Women's and Children's Hospital in Adelaide, South Australia. Children were eligible to take part in the study if they were aged between eight and thirteen years and had been admitted to hospital for minimum overnight stay, following an accidental injury, like road traffic accident, burn, sporting, animal attack, falls >2m. Exclusion criteria for the study comprised of individuals diagnosed with an acquired brain injury or intellectual disability, children under the guardianship of the Minister due to child protection issues, or children experiencing current trauma and abuse (see Table 1 for demographic and trauma characteristic information). Ethical approval was received from the relevant ethic committees.

Table 1

Demographic and trauma characteristics

Variable	CBM-I (*n* =9)	Waitlist controls (*n*=8)	Total participants (N=17)
Age (*M*, *SD*)	10.33 (2.40)	10.50 (2.20)	10.41 (2.24)
Range in years	8-13	8-13	8-13
Male sex (*%*, *n*)	33% (*n* = 3)	63% (*n* =5)	47% (*n* = 8)
Trauma type			
Burns	33.3% (*n* = 3)	-	17% (*n* = 3)
Falls	33.3% (*n* = 3)	37% (*n* = 3)	35% (*n* = 6)
Road traffic accident	11.2% (*n* = 1)	37% (*n* = 3)	24% (*n* = 4)
Motor bike injury	-	13% (*n* = 1)	6% (*n* = 1)
Sporting injury	22.2% (*n* = 2)	-	12% (*n* = 2)
Animal attack	-	13% (*n* = 1)	6% (n=1)
CPSS (*M*, *SD*)	25 (7.24)	24 (7.02)	25 (6.90)
Range	17-36	17-35	17-36

Note. CBM-I =Cognitive Bias Modification–Interpretation; CPSS = Child Posttraumatic Symptom Scale.

As dictated by ethics, parents of children who met the inclusion criteria were introduced to the researcher by the ward nursing staff. The researcher was reliant upon hospital staff having the time for introductions to potentially eligible families. At this time written permission for ‘consent to contact’ at four weeks post injury was obtained from the parent/caregiver.

At 4 to 6 weeks post injury parents were contacted by telephone and children completed a version of the Child Posttraumatic Symptom Scale (see measures for details)

(Foa et al., 2001). Parents received verbal feedback from the researcher on their child's psychological post injury adjustment and were reminded of the study rationale and details. As seen in Figure 1, many parents who had given permission for the 4-week follow-up could not be contacted for the child's trauma screening (n = 60) or, if contact was successful, declined for their child to be assessed (n = 40). In 85% of cases most parents cited that the child had recovered, with the remainder indicating they (the parent) was too busy (2.5%) or the child had had enough of matters relating to the event (2.5%) or, was unwilling to talk (10%).

Parent and child assent forms, information sheets, and a demonstration version of the CBM-I training (issued only to the parents of children assigned to the CBM-I group), was accessed via an individualised web-based link. Hard copies were posted to two families who did not have internet access. In both cases the children were from the 'assessment only' group.

Children who were functioning within the normal range on the CPSS (*n* = 121) were invited to participate in an 'assessment only' phase of the study (data analyses not reported in this study which was separate to the current PhD). This task involved children completing an online battery of questionnaires indexing, interpretation bias style, traumatic stress reactions, trauma-related cognition and mood (see measures section) on one occasion. Of the 83 parents who expressed interest, a total of 34 consents were received. Eight children did not undertake the questionnaires leaving 26 participants who completed the 'assessment only' task.

Children who scored above the clinical CPSS (*n* = 24) cut-off were invited to participate in the intervention arm of the study. Seven individuals who met the eligibility criteria prior to randomisation did not participate due to non-consent. A block randomisation process was used to randomly allocate the 'at risk' individuals (i.e., probable PTSD based on CPSS score) to either the positive CBM-I intervention (*n* = 9) or the wait list control (WLC) (*n* = 8). Prior to the baseline assessment two children from the intervention condition were withdrawn. One parent expressed concern that the intervention might trigger distressing memories and disrupt the child's current functioning, the other parent advised that professional counselling was being sought for the child. Another intervention child and four waitlist control participants also could not be contacted at this time despite repeated attempts and were dropped from the study. Unfortunately, significant attrition occurred, with the majority of the WLC participants (7 of the 8 children) either being uncontactable or not completing the assessment requirements. Figure 1 shows the flow of participants through the study.

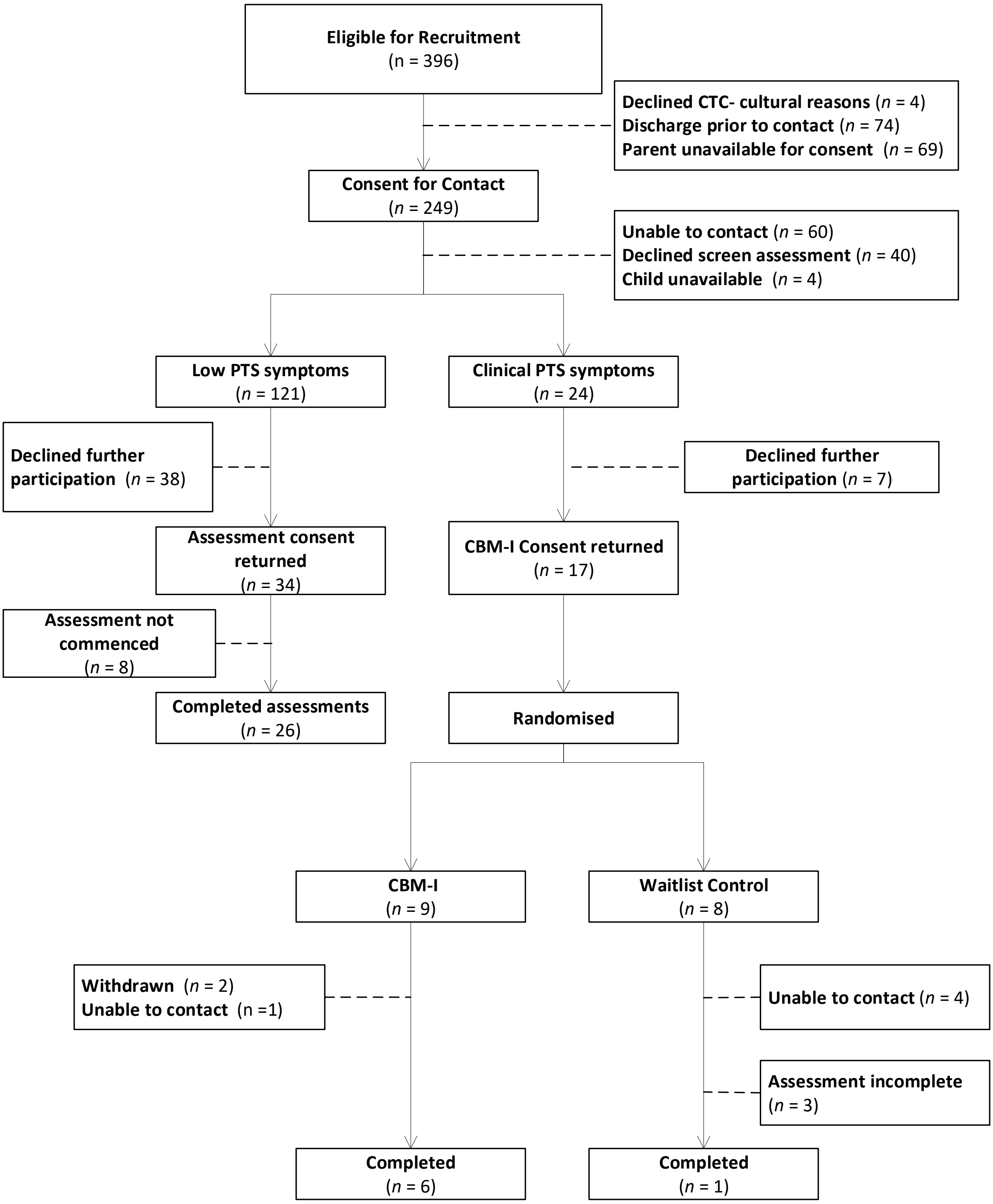

Figure 1. Participant flow chart.
CTC = consent to contact.

Measures

Children's posttraumatic stress (PTS) reactions following the accidental injury was assessed using a 21-item self-report measure (Meiser-Stedman 2010, DSM-5 PTSD supplementary items). This unpublished adaptation of the Child Posttraumatic Symptom Scale (CPSS; Foa et al., 2001) incorporated additional PTSD symptom items but was created prior to the final PTSD criteria released in the DSM-5 (APA, 2013). The measure indexes the frequency of children's traumatic reactions over the past month on a 4-point Likert scale 0 (not at all) to 3 (5 or more time a week). Internal reliability is reported to be .93 (Cronbach's alpha) (R-Meiser-Stedman, personal communication 31 March 2017) which is consistent with studies using the DSM-IV version of the measure (.83 Foa et al., 2001; and .90 Nixon et al., 2013), with .84 obtained for the current sample. At the time this PhD was initiated there was no good psychometric data on the DSM-5 version of the CPSS version used in the study. In consultation with that measure's author (R-Meiser-Stedman, personal communication 7th November 2014), and my own decision making, a score of 16 or above was selected on this 21-item measure for inclusion criteria purposes (i.e., reflected clinically significant symptoms).

The 25-item Child Posttraumatic Cognitions Inventory (cPTCI; Meiser-Stedman, Smith, et al., 2009) assessed participant's trauma-related cognitions. This self-report measure uses a 4-point scale, 1 (don't agree at all) to 4 (agree a lot) to index children's dysfunctional appraisals concerning vulnerability for threat and perception of permanent disturbing change (i.e., *Bad things always happen* and, *The frightening event has changed me forever*). The cPTCI is strongly correlated with the CPSS (r =.63) and internal reliability ranges from .86 to .93 (Meiser-Stedman, Smith, et al., 2009; Nixon, Nehmy, et al., 2010), with test-retest reliability of .78 (over a 2-month interval; McKinnon et al., 2016). Cronbach's alpha for the present study was .94. McKinnon et al.'s (2016) revised cut-off of 46 to 48 on the cPTCI was not available at the commencement of this study but is comparable with Meiser-Stedman, Smith et al.'s (2009) cut-off ≥ 50 which was used to identify participants with clinically significant and maladaptive trauma-related appraisals.

The Test of Interpretive Bias (TIB), created for the present study, was used to index children's perceived threat-interpretation biases. Modelled upon the work of Vassilopoulos and colleagues (2008; 2009), the original TIB format, also used in this study, consisted of two parallel forms (i.e., Form A and B). The forms were counterbalanced across participants. Each form presented 12 ambiguous scenario items featuring domains of threat relevant to PTSD sufferers and circumstances children typically experience (e.g., peer and classroom interactions, appraising the behaviours of self or others). Each scenario was followed by a negative and a benign response. For example, 'Something unexpected happened as you walked into the classroom. You think, *I should always be ready* (negative) or, *It is unlikely to happen again* (benign). Children were asked to imagine the situation happening to them and select a preferred response. A total negative score was calculated with higher scores indicating stronger negative interpretive bias. Internal reliability of the TIB ranged from .65 (Form A) to .74 (Form B).

The Test of Generalisation **-** Recognition task was used as a recognition task to assess the degree to which the newly acquired bias style could generalise to a new task (Mathews & Mackintosh, 2000). It consisted of two parts. In part one, participants completed 12 threat-related ambiguous scenarios using the same format as the CBM-I training (i.e., resolving a word fragment and comprehension response). Unlike the training, each scenario has a title and remained ambiguous. Part two presented the title of the scenario with a negative and benign interpretation. Participants rated each interpretation separately for its sameness to the original story on a 4-point Likert scale 0 (*none*) to 3 (*a lot*). An example is shown in Figure 2. Higher total scores on the negative and benign scales indicate stronger interpretation bias. Cronbach alpha was .70 for the negative scale and .78 for the benign scale.

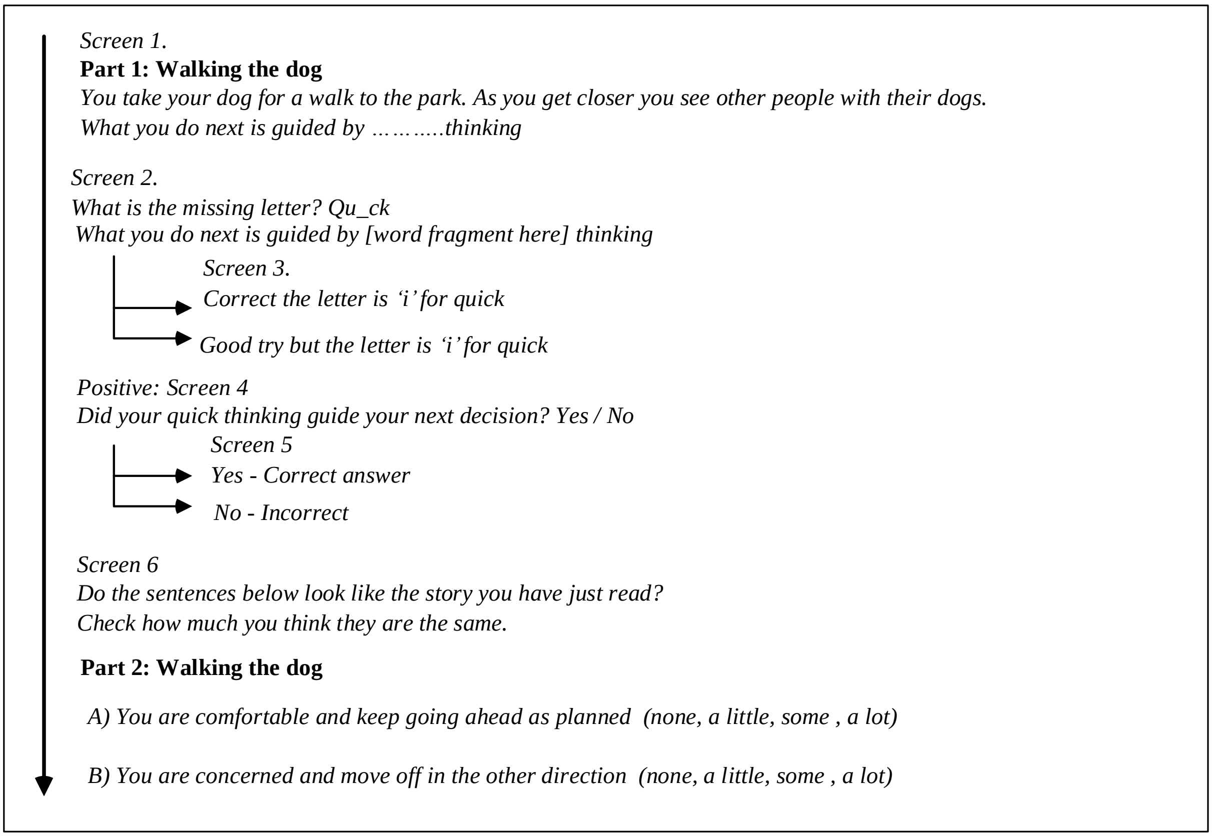

Figure 2. Example of an item on the Test of Generalisation – Recognition task.

Children's anxiety and depression symptoms were indexed using the Children's Depression Inventory-Short form (CDI-S; Kovacs, 1992) and the Beck Anxiety Inventory for youth (BAI-Y; J. S. Beck et al., 2005); T-scores are reported. Cronbach alpha for these measures in the present study were .79 (CDI-S) and .92 (BAI-Y).

Cognitive Bias Training

Children's interpretive biases were modified using the CBM-I regimen (Mathews & Mackintosh, 2000). This involved a series of computerised training trials where participants resolved ambiguous scenarios with the completion of a word fragment. The interpretation was reinforced with a comprehension question and closing statement in accordance with the training objective. An example of a training trial and the sequence of delivery is shown in Figure 3. The stories were based upon concerns known to affect individuals with posttraumatic stress (i.e., exaggerated vulnerability, permanent change) (Meiser-Stedman, Smith, et al., 2009). The trials were reviewed by three independent researchers and pilot tested with same aged children with minor changes being made. Three training sessions (20 trials per training set) were administered. The sixty training trials were all different. Although the optimal quantity of training is unknown, this dosage is consistent with previous research involving clinical populations (Vassilopoulos, Blackwell, et al., 2012) and was decided upon due to concerns of compliance and participant burden within families of children who had just experienced an injury serious enough to lead to a hospitalisation.

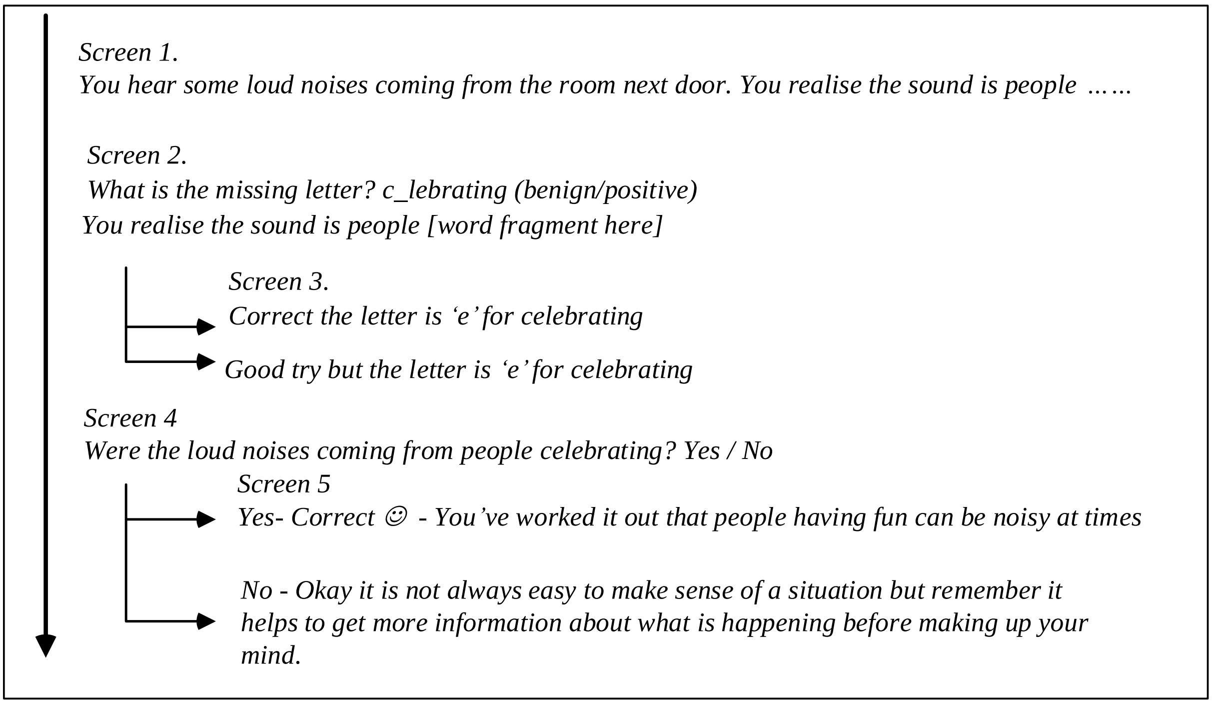

Figure 3. Example of CBM-I benign/positive training trial

The CBM-I training was delivered via a web browser using the Qualtrics software version (2014) (Qualtrics, Provo, UT). The trials were presented in text along with an illustration and audio to enhance children's learning capacity (Mayer, 2008). A tracking indicator was used to assist with participant engagement and sense of achievement (Lau, 2015). In accordance with previous research, children were given a practice trial and a brief imagery exercise (e.g., biting a lemon) prior to the commencement of training (Mathews & Mackintosh, 2000; Vassilopoulos, Moberly, et al., 2012). On average the training sessions took 25 minutes to complete.

Procedure

On receipt of consent (and child assent), parents of the children in the CBM-I group received supplementary information via an electronic link. This information reiterated the aims of the training, the assessment schedule (as follows), an example of a training trial, and a reminder for children to complete the training and assessment independently. Participants received personalised links for access to the online questionnaire battery and CBM-I training program (for the intervention group only). Questionnaires measured children's interpretation bias style, stress reactions, trauma-related cognition and mood on three occasions: baseline, the day prior to first training session (Time 1; T1); the day after last the last training session (Time 2; T2); and six to eight weeks after baseline (Time 3; T3). Children received written and verbal instruction on how to complete the online measures and provided with practice examples. Once completed a trial could not be revisited. Participants were encouraged to take rest breaks as required and to work independently. Participants also had the option for the researcher to be available in person wherever practical (at the child's home or university campus if families did not have access to a computer or the internet) or over the telephone when working through the questionnaires. No participants requested this option or further assistance. On average questionnaires were completed in 35 minutes.

The three CBM-I training sessions were delivered online (at the child's home) and completed over a one-week period with a maximum two-day interval between sessions. On submission of the completed training set the child was issued with the next training link. Participants received a $15 (assessment only group) or $45 (intervention and WLC) gift voucher for their involvement. Following the waiting period children in the WLC condition were offered the training sessions, although no child took up this offer. Parents of WLCs were encouraged to contact the researcher if the child experienced difficulties whilst awaiting CBM-I intervention. No parent made such contact.

Statistical Analyses

Given that attrition resulted in significantly smaller cell sizes than anticipated, individual reliability of change analyses (Jacobson & Truax, 1991) were adopted over group analyses to assess the modification of children's maladaptive interpretation biases and change in trauma-related and mood symptoms. These change indices are appropriate for small n studies and identify whether an individual has achieved a level of change that is both statistically significant (i.e., reliable change) and meaningful (i.e., a shift from the clinical to the normal range of functioning). Following Jacobson and Truax (1991), reliable change was defined as a change score from pre-to post intervention of at least two standard deviations from the participant's baseline score. Criterion for defining recovery is indicated when participants show non-problematic levels of symptoms following treatment (i.e., below the clinical cut-off on the outcome measures, in this case, a score on the CPSS < 16, cPTCI < 50, BAI-Y and CDI-S T-scores < 60). A cut-off for the Test of Interpretive Bias (TIB) score ≥ 5 (1.5 *SD* above the mean) was decided upon to reflect a clinical level of negative interpretation bias.[7] Clinically meaningful change on the TIB was defined as ≥ 50% reduction from baseline score. The same criterion was adopted for Test of Generalisation - Recognition task. As noted earlier, a 21-item DSM-5 version of the CPSS was used to assess children's trauma-related symptoms. However, as there was no good psychometric data available for this measure it was decided that RCI analyses be based upon the 17 items that reflect the DSM-

[7] Psychometric information to calculate RCI for the TIB was obtained from data derived from Study 1 in Chapter 2.

IV CPSS measure (Foa et al., 2001), which allowed psychometric data from Nixon et al. (2013) to be used to calculate the RCI's.

Results

In line with previous research it was predicted the CBM-I positive training would facilitate the modification of children's threat-related negative interpretation biases. Participant's scores on the interpretive bias (e.g., TIB) and outcome measures (e.g., CPSS, cPTCI, BAI-Y and CDI-S) given at each assessment (i.e., baseline, post assessment and 6 weeks follow-up) are displayed in Figures 4 to 9 for CBM-I participants, and Figures 10 and 11 for the waitlist controls. On average participants commenced and completed the CBM-I training sessions at 10 and 12 weeks posttrauma respectively. Assessment were completed on average at 9.9 weeks (Baseline), 13.2 weeks (Post-training) and 19.8 weeks (Follow-up) from the date of injury. Table 2 shows training and assessment timeframes for each participant

Table 2.

Number of day's posttrauma participants began and completed CBM-I training and assessments.

	Number of days posttrauma				
	Assessment			CBM-I training	
Participant ID	Baseline	Post-training	Follow-up	Began (T1)	Completed (T3)
P1	86	114	169	92	108
P2	76	93	141	86	89
P3	50	67	117	62	64
P4	62	112	141	64	107
P5	46	64	127	46	61
P6	96	108	-	97	106

Note. T1= first of three 20 trial training sessions; T3 = final session; - = missing data.

Following CBM-I training the three participants who were above the clinical cut-off at baseline (P3, P4 and P5) reported a reliable change in negative interpretation bias when processing ambiguous situations. The change for two participants (P3, P5) was both reliable and clinically significant (i.e., reduction of 50% or more). As indicated in Figure 4, however, these changes were not maintained at 6-week follow-up for two participants (P3 and P5) whereas P4 continued to make improvement over the assessment period. Two of the six CBM-I participants completed the Test of Generalisation (TOG) - Recognition task (see Figure 5), designed to assess the generalisation of modified interpretation bias to a new task (Mathews & Mackintosh, 2000). Unfortunately, due to technical error the TOG questionnaire was not administered at baseline to the other 4 participants. Both participants (i.e., P5 and P6) who completed the pre and post TOG scale reported a reliable reduction in negative interpretation bias and a reliable increase in positive interpretations when processing new material following training. Clinically significant change (i.e., reduction of 50% or more) on the *negative* scale was however only achieved for one participant (P6).

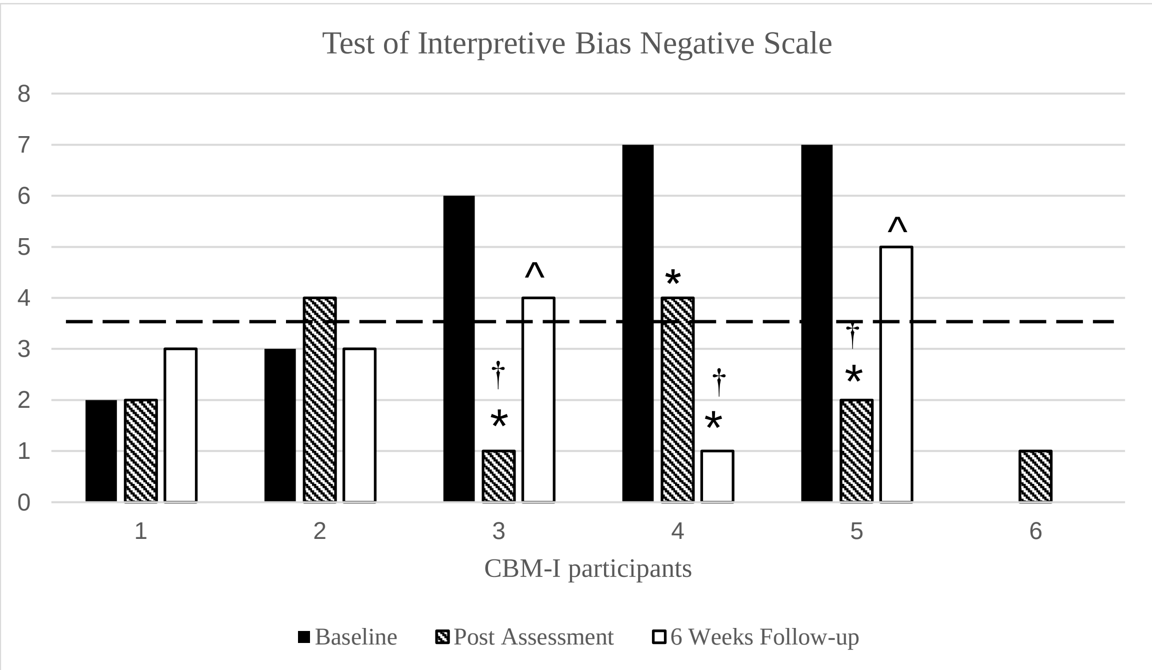

Figure 4. CBM-I participant scores on the Test of Interpretive Bias – negative scale at baseline, post treatment and 6 weeks follow-up assessment. Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; ^ = reliable change (RCI) between post assessment and 6-week follow up; † = clinically significant change (50% reduction in score) between assessment intervals. P6 scored 0 at baseline and did not complete follow-up.

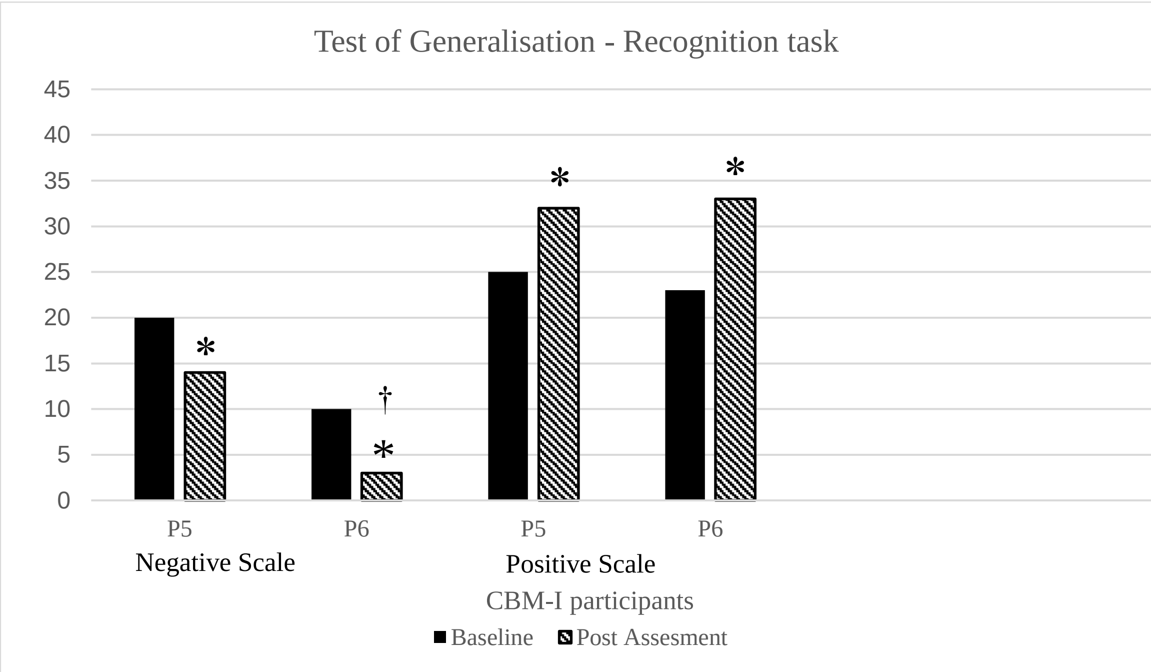

Figure 5. CBM-I participant scores on the Test of Generalisation -Recognition task – negative and positive scale at baseline and post treatment assessment; * = reliable change (RCI) between baseline and post assessment; † = clinically significant change (50% reduction in score) between assessment intervals.

A key aim of the study was to assess the influence of CBM-I training on children's trauma-related symptoms associated with the event that resulted in their accidental injury. As indicated in Figure 6, three participants' baseline scores on the CPSS were sub-threshold (P1, P2, and P4), indicating a borderline level of trauma-related symptoms[8]. Both individuals

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[8] Participants 1, 2 and 4 have been included in the analyses as they were above the threshold according to the initial CPSS screening score of 16+. However, adjustment with the use of the DSM-IV scoring to report on the results placed these participants' CPSS scores at the subthreshold level.

reported further, non-significant, decline in symptoms over the assessment phase. The effect of CBM-I training for children with a higher level of trauma symptoms (i.e., P3, P5, and P6) was varied. No statistically reliable change in trauma symptoms was observed immediately following the CBM-I training for these participants, although one child (P6) shifted from the clinical to the normal range on the CPSS at this time. Further, inspection of the post assessment data showed an unexpected increase in trauma symptoms after training for two individuals (P4, P5). Parental feedback advised one child (P5) had undergone a medical procedure relating to the accidental injury just prior to the post assessment. The parent of P4 advised that the child's initial reported level of trauma symptoms appeared incongruent with those being observed at that time. Despite possible underreporting at baseline (explaining the observed pre-post increase in CPSS scores), P4's scores remained unchanged between post and follow-up, overall indicating at a minimum the intervention had no effect. Further, this finding suggests although the CBM-I intervention was ineffective for this child, it was not associated with any potential harm. However, two other participants with clinically elevated symptoms at baseline (P3, P5) achieved good end state functioning (i.e., shift from the clinical to the normal range of functioning) with significant and meaningful reliable change scores reported at 6 weeks follow-up.

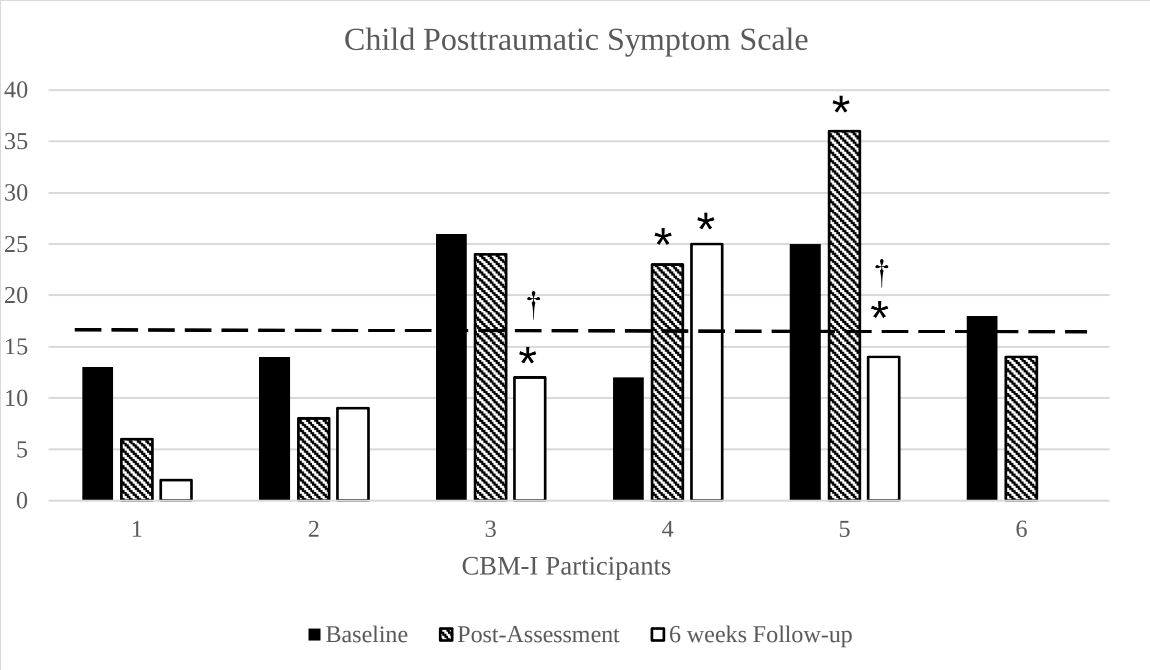


Figure 6. CBM-I participant scores on the Child Posttraumatic Symptom Scale at baseline, post treatment and 6 weeks follow-up assessment. Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; † = clinically significant change (normal range of functioning) between assessment intervals. P6 missing follow-up data.

As shown in Figure 7, intervention effects for the two participants (P3, P5) with a high level of trauma-related appraisals were not observed immediately following the training exercises. The level of trauma related appraisals either remained static (P3) or temporarily increased (P5). As noted earlier, the increase in P5's dysfunctional appraisals after training may have been associated with other injury-related events (e. g., medical procedure). However, P5 showed a reduction in dysfunctional appraisal score from post assessment to follow up assessment; although a reliable change, it was not clinically meaningful (i.e., child's score remained within the cPTCI clinical range). One participant (P3) reported a reliable change in trauma-related appraisals at 6 weeks follow-up. This improvement positioned P3 just short of the normal range of functioning on the cPTCI scale. Figure 7 also shows the dysfunctional appraisal scores for the remaining CBM-I participants' (i.e., P1, P2, P4 and P6) whose scores placed them within the normal limits at baseline, where they stayed over the assessment phase (although P4's post-score just placed them in the clinical range before returning to normal limits at follow-up).

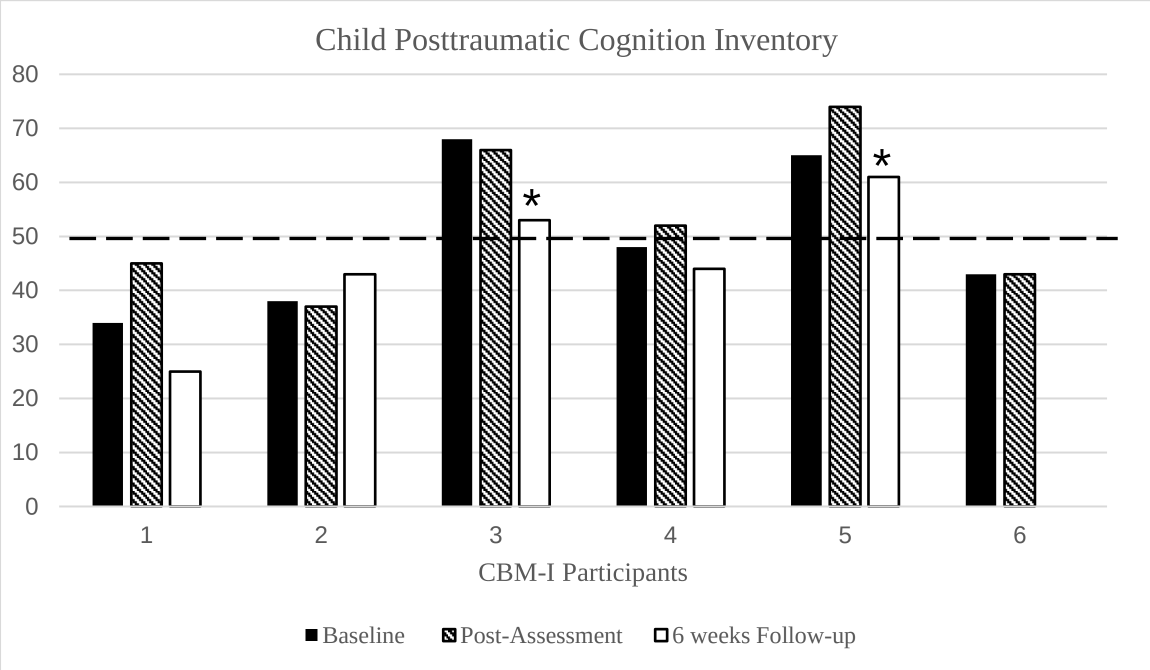


Figure 7. CBM-I participant scores on the Child Posttraumatic Cognition Inventory at baseline, post treatment and 6 weeks follow-up assessment. Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; † = clinically significant change (normal range of functioning) between assessment intervals. P6 missing follow-up data

The effects of CBM-I intervention on children's anxiety symptoms are presented in Figure 8. As shown earlier, CBM-I participants (i.e., P3, P4 and P5) with elevated symptoms on other measures (i.e., TIB, CPSS, cPTCI) also tended to report higher levels of anxiety. As can be seen in Figure 8, P1 and P2's low level of anxiety (i.e., symptoms in the normal range) remained stable over the assessment phase. No positive effect of CBM-I training on participants with high level anxiety was observed at post assessment, although a statistically reliable change was identified for one child (P3) at 6 weeks follow-up (i.e., a shift from the moderate to a mild level of anxiety). Three children (P4, P5 and P6) reported a significant *increase* in anxiety symptoms following the training task. This result placed P6, who was initially in the normal range, to within the clinical category, albeit at the mild level. Follow up data was not available for P6. Both P4 and P5 remained within the anxiety clinical range at 6 weeks follow up assessment, although a reliable change in P5's anxiety score was observed from post to follow up assessment.

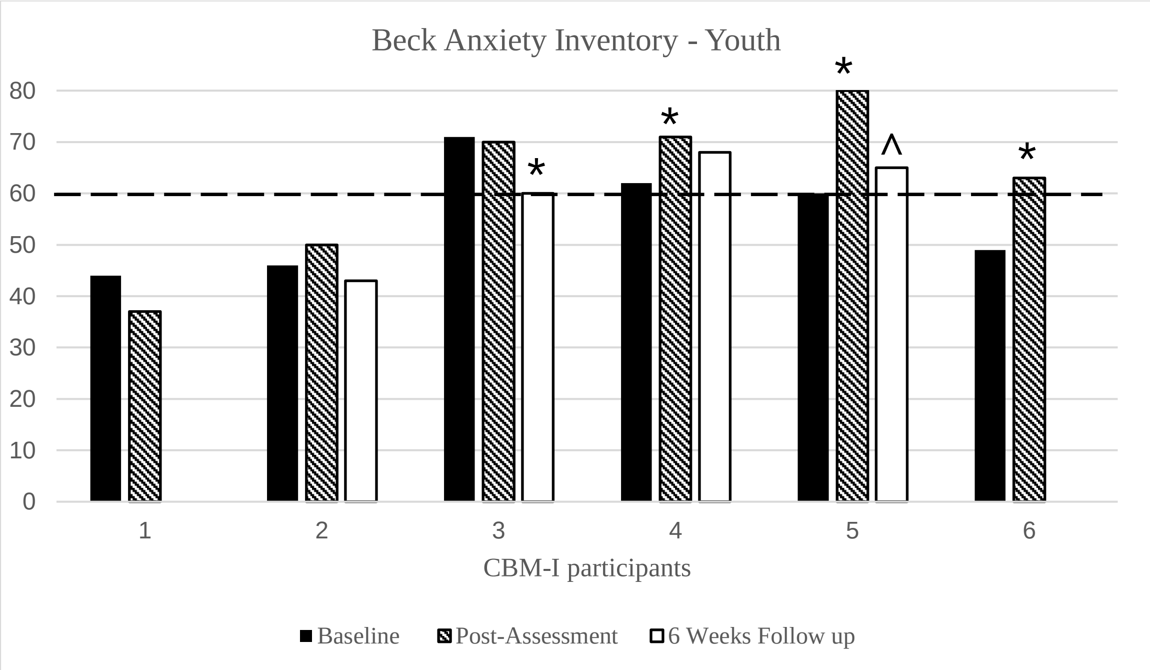


Figure 8. CBM-I participant scores on the Beck Anxiety Inventory – Youth at baseline, post treatment and 6 weeks follow-up assessment. Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; ^= reliable change (RCI) between post and 6-week follow-up; † = clinically significant change (normal range of functioning) between assessment intervals. P1 and P6 missing follow-up data.

The final results for the CBM-I participants, Figure 9 summarises depression symptoms findings. Five of the six participants (i.e., P1, P2, P3, P5 and P6) did not report problematic depression symptoms at baseline. Although some fluctuation occurred over the assessment phase these participants all stayed within normal limits on the CDI-S. Reliable change at post assessment was observed for P2, but this child was already within the normal range of functioning at baseline. Depression scores for the clinically affected child (P4) remained elevated following CBM-I training. A decrease in P4's depression symptoms at 6 weeks follow-up was not statistically significant.

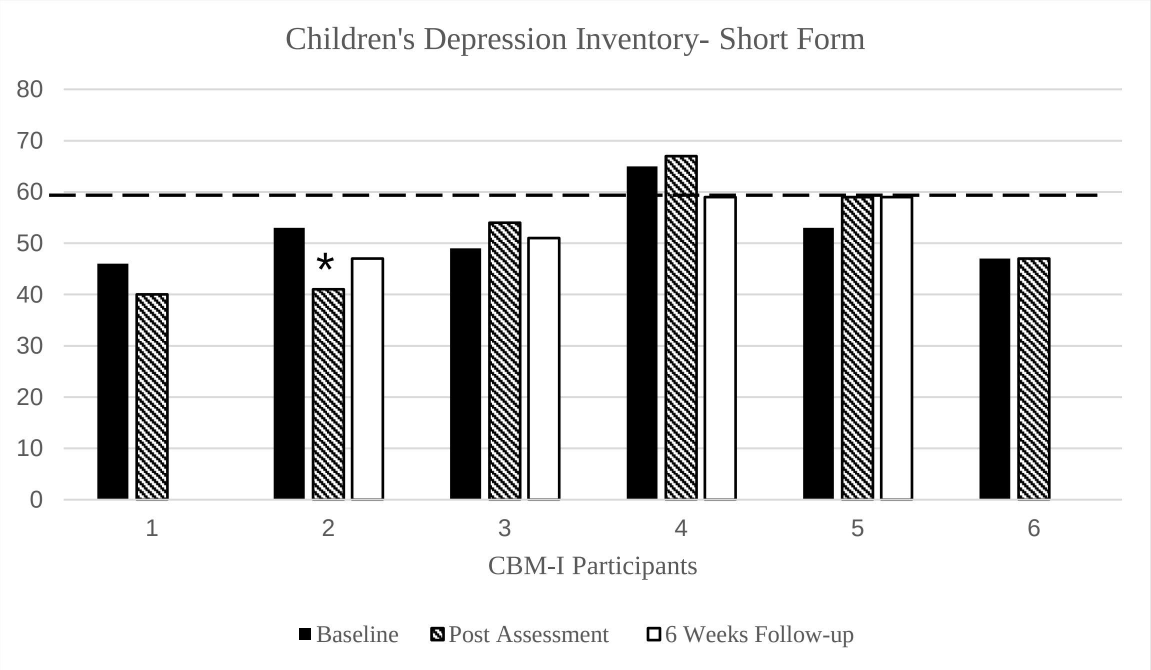
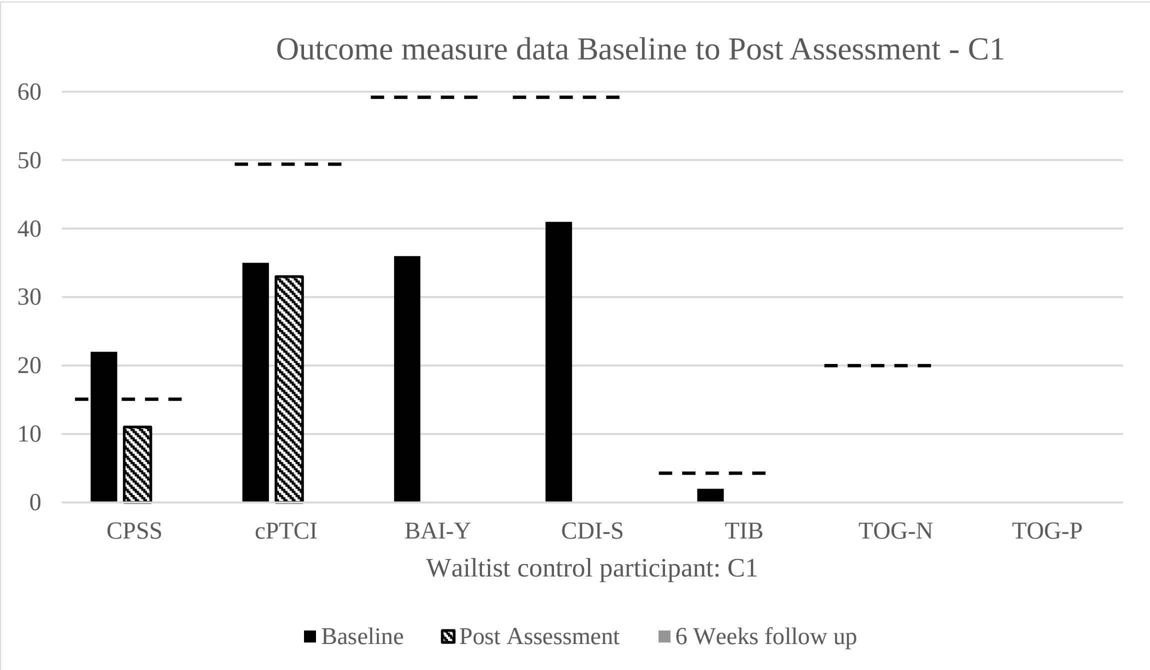


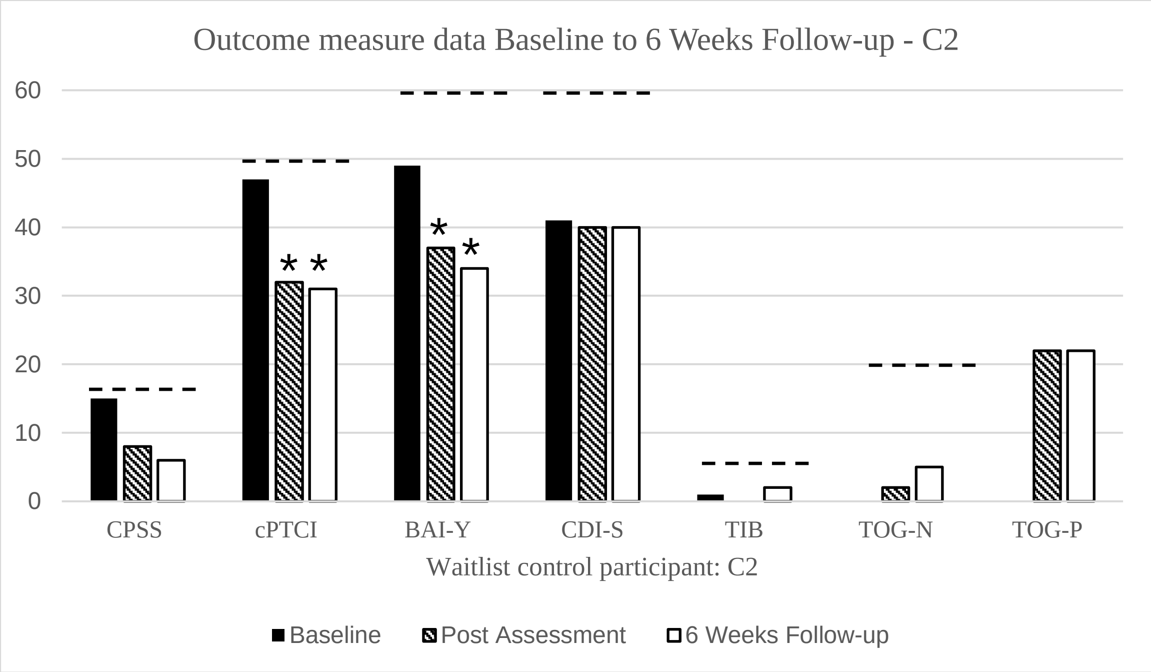
Figure 9. CBM-I participant scores on the Children's Depression Inventory- Short Form at baseline, post treatment and 6 weeks follow-up assessment. Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; † = clinically significant change (normal range of functioning) between assessment intervals. P1 and P6 missing follow-up data.

Results for two control participants were available. Analyses was limited to the trauma symptom measures for one participant (participant C1 Figure 10) due to incomplete data (only the CPSS and cPTCI were completed at post assessment). CPSS baseline scores for participant C1 fell to within the normal range at post assessment however, the drop-in score was not enough to reach statistical significance. This participant (C1) reported low baseline and post assessment scores on the cPTCI. Similarly, control participant C2 (see Figure 11) had subthreshold trauma symptoms at baseline and was asymptomatic at post and 6 weeks follow-up assessments, although the change in symptoms was statistically non-significant.

Further, a reliable change in participant C2's level of trauma-related appraisals and anxiety symptoms was observed at post assessment, with gains maintained at follow-up. However, the improvement on these measures only represented change from *within* the normal range of functioning. Further, the child's level of negative interpretation bias and depression symptoms at baseline were also within normal limits and remained unchanged with successive evaluations.



Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory for Youth; CDI-S = Children's Depression Inventory – Short Form; TIB = Test of Interpretive Bias - negative scale; TOG-N/P = Test of Generalisation - Recognition task – negative and positive scales (scale not completed for C1). Figure 10. Wait list control participant C1 scores on the outcome and interpretive bias measures at baseline to post assessment. --- Dashed line reflects clinical cut-off; Missing post data (BAI-Y, CDI-S, TIB). Missing all follow up data.



Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory for Youth; CDI-S = Children's Depression Inventory – Short Form; TIB = Test of Interpretive Bias - negative scale; TOG-N/P = Test of Generalisation - Recognition task – negative and positive scales.

Figure 11. Wait list control participant C2 scores on the outcome and interpretive bias measures at baseline to follow up assessment. --- Dashed line reflects clinical cut-off; * = reliable change (RCI) between baseline and post assessment or between baseline and 6-week follow-up; C2 post scores on TIB = 0; Missing baseline data on the TOG - N/P

Discussion

The primary objectives of this pilot study were to examine the effectiveness of the positive CBM-I intervention to modify children's negative threat-related interpretations and attenuate trauma-related symptoms for children with PTSD following accidental injury. It was predicted that children who received the CBM-I intervention, compared with waitlist controls, would show reductions in negative interpretation biases and improvement in trauma-related symptoms. Unfortunately, due to the high level of attrition and/or failure to complete further assessments (especially control children), the original analytic plan of direction comparisons between groups was not possible. Therefore single-case analyses were conducted, and review of findings are mostly based upon outcomes from the CBM-I intervention participants. Despite some minor alterations I found no conclusive evidence that CBM-I intervention was able to modify children's negative threat-related interpretation biases. Contrary to prediction I did not observe reliable change in children's trauma symptoms, maladaptive appraisals, and anxiety and/or depression symptoms following the training exercises, although some significant change in trauma-symptoms and mood was observed by follow-up.

The inability to modify children's threat-related negative interpretation biases is inconsistent with previous meta analyses (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017) and recent clinical investigations of CBM-I with anxious and depressed youth (de Voogd et al., 2018; LeMoult et al., 2017). Further, unlike the present study, training effects have been observed for children with pre-existing negative interpretation biases (Muris et al., 2008; Salemink & Wiers, 2011). However, the observation of such minor changes might not be maintained with short trainings (e.g., 3 - 4 sessions), thus also consistent with previous research (Micco et al., 2014), the initial improved interpretation bias style observed for two of the three participants in the present study seemed to diminish by follow-up, possibly indicating a reliable relapse. However, in the absence of a comparative waitlist condition, this does not support a reliable pattern of effects within the CBM-I training group. Further research with larger samples will hopefully provide the opportunity to better understand what differentiates participants who show both initial reduction and progressive improvement in interpretation style (which generalise beyond the training setting) from those who might not maintain such gains.

Even when negative interpretation bias was successfully improved, it did not appear to translate to a reduction in trauma-related symptoms. This result is inconsistent with adult-based studies investigating CBM-I training effects on trauma-related appraisals and symptoms with analogue trauma exposure (Woud et al., 2018; 2012; 2013). There are however several explanations for this discrepancy.

First, and probably most important of these explanations concern developmental factors. Therefore, to understand how this may impact upon findings it is important to note the unique differences between child and adult-based research. For example, compared with adults, children have limited vocabulary skills, shorter attention span and different cognitive capacities and, their motivation to take part in the research may be different (Punch, 2002). Further, although the CBM-I is presented in a concrete format, it still requires a level of abstraction to generalise learning. Thus, from a developmental perspective, compared with adults, children may have less cognitive capacity to achieve this objective (Berk, 2009).

Methodological explanations might also explain findings. Children in the current study worked on the training trials independently, whereas in other successful CBM-I investigations parents have been involved (Lau et al., 2013; Reuland & Teachman, 2014). Further, depending on the circumstances and child age, active parent participation is frequently required in research with children (Prior & Van Herwegen, 2016) and this is certainly the case with child-based trauma therapy (Trauma-Focused CBT: Cohen & Mannarino, 2008). Consequently, as children may require more practice, coaching and support from others (i.e., correcting mistakes) to apply new skills to other situations, parent involvement may be needed (Berk, 2009). Furthermore, in contrast Woud et al. (2018; 2013; 2012) children in the current study were exposed to a variety of traumatic events that were personally experienced (i.e., real life traumas vs. Woud's use of standardised trauma film stimulus), although not all events would be considered Criterion A events. As such there were a range of factors that might have influenced the current findings.

An additional factor that complicates the interpretation of the current findings was the decision to base analyses on the CPSS using DSM-IV scoring (due to availability of appropriate psychometric data for RCI analyses). This meant that participants' analysed scores were lower than the original scores that allowed them into the intervention arm of the study (the latter scores being based on a newly constructed measure designed to anticipate the DSM-5 PTSD criteria). Accordingly, there was less room for these scores to change, and if DSM-IV CPSS cut-off scores (Nixon et al., 2013) were applied to these scores, these children would be considered to have a subthreshold level of symptoms and therefore possibly less responsive to CBM-I effects.

In addition to the above, other methodological explanations exist, for example the number of training sessions may have been insufficient to facilitate change in trauma-related symptoms. The three training sessions used was based upon considerations of participant burden and earlier research at the time the study was initiated that treatment effects with anxiety symptoms using this dose could be observed (Lau et al., 2013; Vassilopoulos et al., 2009), although this has not been the case in recent clinical samples (Orchard et al., 2017). Nonetheless, there is some evidence to suggest greater intensity and more frequent dose of CBM-I (e.g., 8-15 sessions over 4 to 5 weeks) can lead to reduction in psychological symptoms (Klein et al., 2015; Reuland & Teachman, 2014). However, the lack of substantial change in participants' level of interpretation bias immediately following training suggests a 'manipulation failure' whereby it is not surprising that symptoms remained unchanged (Clarke et al., 2014). Moreover, the unique characteristics of the current sample may provide a further explanation for the study results. For example, due to nature of the index trauma (i.e., trauma following accidental injury) some participants remained engaged with medical services (i.e., due to check-ups, recovery complications, need for further medical procedures) during the study. Although it is unclear to what extent these factors may have affected the null findings, anecdotal parental feedback suggests this may account for at least one child's decline in functioning. Further, although the CBM-I training tasks were designed to tap into the domains of threat identified as being central to PTSD, the threats were set in typical situations children encounter (i.e., peer interaction, school and other activities). Therefore, it is possible children's threat-related interpretation biases associated with trauma may have been less relevant when processing social contexts.

A proportion of CBM-I participants above the clinical threshold experienced change in trauma symptoms and dysfunctional appraisals at follow-up. Reasons to explain this occurrence beyond the treatment intervention include natural recovery, placebo and/or demand effects, and the timing of recruitment. Many children who experienced traumatic events go onto recover without the need for treatment, with recovery likely to occur within the first six months (Le Brocque et al., 2010). Although children were entered into the intervention phase of the study in accordance with the DSM-5 PTSD diagnostic criteria (i.e., at least one month after trauma exposure) (APA, 2013), this timeframe for children with subthreshold or mild symptoms may have prematurely captured individuals who might ordinarily have experienced natural recovery. Further, the problems with retention of the control participants, and the fact that this was a relatively short control period even if participants had been retained, indicates the process of natural recovery cannot be excluded. Furthermore, it has been suggested CBM-I effects may be influenced by placebo, demand or practice effects (i.e., participants simply getting better at doing the task because the tools used to measure interpretation biases may closely resemble the training trials used to modify biases) (Cristea, Mogoașe, et al., 2015). Although, others have expressed an alternate view that demand characteristics are insufficient to explain the findings of CBM and provide various counterarguments to rebuttal this suggestion (for additional explanations see for additional explanations see for additional explanations see for additional explanations see MacLeod & Mathews, 2012). One example offered by MacLeod and Mathews (2012) concern the usually subtle differences between CBM conditions that are not communicated to and therefore likely to be unknown to participants. A demand effect in this situation requires the individual to correctly infer what is expected *and* be motivated enough to simulate the anticipated change. In addition, in response to possible placebo and/or demand effects, others have emphasised the need for further studies to establish the clinical utility of CBM-I for youth populations (Lau, 2015). Efforts were made in the present study to minimise any confounding effects (e.g., the use of two different measures of interpretive bias, counter-balancing of one of these measures, use of control condition), as suggested by previous researchers (Lau, 2013), however it is possible these factors account for the current study results.

My finding that CBM-I had no immediate effect (i.e. pre-post change) upon anxiety symptoms is consistent with other clinical studies (Chan et al., 2015; Fu et al., 2013; Orchard et al., 2017; Salemink & Wiers, 2011) but discrepant with the findings of others (Klein et al., 2015; Lau et al., 2013; Reuland & Teachman, 2014; Vassilopoulos et al., 2009). Although one child demonstrated improvement between pre- to follow-up in the study, obviously this could have been an outlier, and weight should not be placed on this finding until further replication. Similarly, the null effect of CBM-I intervention on depression symptoms is in keeping with research investigating depression focused CBM-I with depressed youth (LeMoult et al., 2017; Micco et al., 2014). However, although the current study was focused on anxiety/ trauma and not depression per se, this result is not in line with traditional trauma-focused CBT studies that have shown depressive symptoms often improve for children with PTSD following cognitive-behavioural therapy treatment (Meiser-Stedman et al., Meiser-

Stedman et al., Meiser-Stedman et al., Meiser-Stedman et al., 2017; Nixon et al., 2012; Smith et al., 2007).

The study had several limitations, foremost was the small sample size, which was compounded by attrition resulting in the absence of an adequate control group. This clearly limits the confidence in any positive findings and impacts the generalisation of the results. Specifically, it remains unclear if the CBM-I intervention produced the observed effect in cases where there was symptom improvement over time or whether individual factors account for the change. The size of the sample reflects the challenges with recruitment of the clinical sample within a hospital setting and the consequences of attrition. There were some system barriers in place that also resulted in challenges with recruitment (i.e., having to work through nursing staff who were frequently extremely busy, some of whom did not see the value of the research). Further, the small sample size has implications for not only future researchers but potentially would have to be addressed if this was to be used in clinical practice as an actual intervention (even though it remains unclear at this time whether this would even be suggested given the current findings). Furthermore, the subclinical status of participants within sample further preclude the adequate testing of the CBM-I intervention with children experiencing PTSD symptoms associated with Criteria A type events. Further, the reliance upon children's self-report for all outcome measures has the potential for bias (MacLeod et al., 2009), and combined with the associated loss of valuable information from significant informants (i.e., parents, caregivers and/or medical staff), meant that other possible impacts (positive or negative) of the CBM-I treatment outcomes might have not been captured.

Notwithstanding these caveats, strengths of this research include the adaptation of the CBM-I training scenarios for relevance with a child trauma sample (i.e., trauma-related themes and dysfunctional appraisals such as exaggerated vulnerability, overestimation of threat and negative self-view), the inclusion of a follow-up assessment, and the flexibility of the delivery of CBM-I intervention comprising an online assessment and training format which gives wide access to the program for children with PTSD who might reside across a range of locations (metropolitan, rural, interstate). In terms of recommended improvements for further research in the area, the inclusion of significant informants (i.e., parents or caregiver) to assess and monitor children's trauma-related symptoms and associated injury events is needed. Design improvements that involve the use of a PTSD diagnostic interview may assist and improve the recruitment and selection process of children who may benefit from this intervention as well as further development of the CBM-I training items (i.e., content specific- scenarios involving trauma relevant situations) to improve the modification of trauma-specific interpretation bias. The replication of this research with a larger sample and control group is a priority to determine the efficacy of the CBM-I intervention for children and youth PTSD populations.

In closing, this pilot study is the first study to investigate CBM-I training as a possible intervention for children with posttraumatic stress following accidental injury. Although the conclusions that can be drawn from its findings were limited by several factors, it represents a critical first step in this important field of study.

CHAPTER 5

General discussion

This thesis was the first to identify the presence and potential influence of negative/threat-related interpretation biases on trauma symptoms in children using non-questionnaire methods, and the first, to my knowledge, to assess the efficacy of a cognitive training intervention (positive CBM-I) for children from both unselected and clinical populations following a stressful and/or traumatic event. A brief summary of the results is presented, followed by a discussion of the relevance of this program of research, how the findings align with the current literature, and their implications

A lack of assessment tools to measure threat-related interpretation biases with trauma and ambiguous situations led to the creation of the Test of Interpretive Bias (TIB) - an index of threat-related negative interpretations in children. Study 1 (as outlined in Chapter 2) was conducted to assess the TIB's capacity to identify children's threat-related negative interpretation biases associated with PTS. It was moderately correlated with measures of trauma symptoms and negative trauma-related beliefs (i.e., the Child Posttraumatic Symptom scale, CPSS; and the Child Posttraumatic Cognitions Inventory; cPTCI), as well as the Ambiguous Situations Test (AST), a measure of interpretation bias in social ambiguous contexts). Contrary to prediction, the TIB demonstrated similar levels of correlation with measures of anxiety and depression. Further, although the TIB demonstrated some capacity to identify children with high levels of trauma and depression symptoms, it had greater specificity than sensitivity, (i.e., detecting children with low levels of symptoms). Furthermore, although I found threat-related negative interpretation biases did account for modest levels of children's trauma symptoms and beliefs, my prediction that it would identify those at increased risk of developing symptoms over time was not supported.

Study 1 provided the groundwork for the subsequent two studies that assessed the efficacy of positive CBM-I intervention to modify children and adolescent's threat-related interpretation biases (i.e., improve adaptive interpretation bias style) and consequently their trauma symptoms following a stressful and/or traumatic event. The first of two short-term longitudinal investigations were conducted over a 6-month period with an unselected child sample (Study 2; Chapter 3). My prediction that a four-session positive CBM-I intervention would reduce trauma symptoms was not supported, although I found some evidence it reduced anxiety. There was no gender or age moderator effects on trauma or depression symptoms. However, female gender moderated CBM-I treatment on the AST (i.e., girls reported fewer negative interpretation biases associated with social ambiguity overtime) and age moderated anxiety (i.e., following CBM-I, older children reported less anxiety). Children did not report significant improvement in their level of positive interpretation biases on the TIB or AST, nor a reduction in threat-related interpretation biases as measured by the TIB following training. I found that children's state mood (e.g., level of happiness) improved immediately after the positive CBM-I training but no evidence to suggest that the intervention had any preventative effect, that is, it did not reduce the chance of children having later clinical problems.

My third and final study of the thesis (Chapter 4) assessed the efficacy of three sessions of positive CBM-I to modify threat-related interpretive biases associated with traumatic /stressful events and trauma symptoms over a three-month period. This was a pilot study conducted with a clinical sample of children who were experiencing posttraumatic stress symptoms following an accidental injury. Single case analyses showed some improvement for three of the six participants in negative interpretations bias immediately following the training sessions. Three participants showed a reduction in trauma and anxiety symptoms at the 12-week follow-up assessment. The only one of the eight control participants who completed the study showed reliable reductions in trauma and anxiety symptoms. Discussion about the findings and the wider implications of this body of work will now follow.

Study 1 set out to examine a test created to index children's threat-related interpretation biases associated with ambiguity. The Test of Interpretive Bias (TIB) was correlated with the AST measure of social interpretation biases, and symptom outcome measures. This provided some evidence of the TIB's convergent validity with other measures of negative cognition. Its moderate relationship across all symptom measures (i.e., trauma, maladaptive cognition, anxiety and depression) suggest that while anxiety and depression may be defined by different cognition and emotions (i.e., anxiety typically involves anticipation of future danger, harm and fear, whereas depression is usually associated with attributions of loss or failure and/or anguish) like PTSD, they are conceptualised to contain an element of threat (Brady & Kendall, 1992). The TIB's correlations with a range of symptom measures suggest it indexed a broad range of interpretation biases and might be better considered a *general* measure of negative interpretation biases associated with ambiguity rather than one specific to trauma. This finding illustrates an issue that has been seen with other child research - that anxiety and depression is frequently comorbid (Brady & Kendall, 1992; Cole et al., 1997) and that the biases measured by the TIB might represent a trans-diagnostic variable (Muris et al., 2005) even though it was designed to be somewhat trauma specific. Further, evidence of ambiguous threat interpretation has also been observed with studies investigating children's hostile interpretation of the intention of others (Dodge, Murphy, & Buchsbaum, 1984; Vassilopoulos, Brouzos, et al., 2015; Waas, 1988) and threat interpretations associated with childhood anxiety disorders (i.e., panic disorder, separation disorder, obsessive compulsive disorder (Micco, Hirshfeld-Becker, Henin, & Ehrenreich-May, 2013) as well as studies with traumatised adults (Amir, et al., 2002; Kimble et al., 2012;

Kimble et al., 2002). These findings, along the result of the current study, suggest the TIB was able to capture threat-related biases associated with ambiguity which appears to be an underlying mechanism across various childhood disorders.

The observation that the TIB correlated just as highly with anxiety measures as it did with depression measures is also suggestive of problems with item content specificity that has been previously shown to influence change in children's interpretations biases and symptoms (Klein et al., 2015; Micco et al., 2013). To minimise children's risk of potential distress in completing the measure, the TIB items were based upon the underlying themes of the cPTCI measure (i.e., trauma related appraisals concerning vulnerability, mistrust, self-blame, and permanent change) but did not include specific material relating to traumatic events (i.e., accident, injury to self or others) which might have invoked an overly strong negative response if too representative of the trauma that the child had experienced. Although the aim of the TIB was not to cause distress with trauma-related reminders but to assess threat-interpretations associated with ambiguity, the items may have been too broad to elicit or fully capture bias interpretations following children's trauma-related experiences. As mentioned previously, the typical threat-related concerns of those with PTSD were embedded in the TIB ambiguous scenario items but using social situations children routinely encounter as the context (i.e., school, peer activities); this may have targeted biases more associated with social difficulties rather than stressful and/or traumatic experiences.

The study's identification of interpretation bias in an unselected child sample provides further evidence that children from non-clinical populations exhibit threat processing biases (Muris, Luermans, et al., 2000; Muris et al., 2005). In addition, the repeated assessment using the bias (TIB and AST) and outcome measures revealed strong positive correlations over the 12-week period which suggests some stability of these constructs and test-retest reliability of the TIB. This is consistent with previous longitudinal research that has shown the stability of children's negative interpretation biases and anxiety (Creswell & O'Connor, 2011; Muris et al., 2004) as well as research on the stability of unhelpful appraisals with PTSD when measured with self-report questionnaires (Dunmore, Clark, & Ehlers, 2001; Meiser-Stedman, Dalgleish, et al., 2009). Further, prospective investigations conducted over several years have shown that negative biases can be extremely stable. Alloy et al.'s (2006) study of young adults over 2 ½ years found non-symptomatic individuals who continued to have a negative cognitive style at each prospective assessment, relative to individuals without a pessimistic explanatory style, were at 7 times greater risk for later onset and recurrence of major depression. Similarly, a 5-year investigation with a child community sample found that individuals with a pre-existing pessimistic explanatory style had a more pessimistic cognition at each subsequent 6-month assessments over the study period and, as children grew older, this processing bias style predicted later depression symptoms (Nolen-Hoeksema, Girgus, & Seligman, 1992). These studies provide some evidence that negative interpretation biases persist over time and are associated with the risk of later psychopathology. Therefore, it is likely this also occurs for children following trauma but needs to be studied over a longer period than has been currently done to date.

I found the presence of a negative interpretation bias improved the recognition of children with high and low symptoms on all the outcome measures. Notably negative threat-related interpretation biases accounted for 8% of trauma symptoms in children. This suggests interpretation biases play a small but important role in trauma symptoms which has not previously been identified in child PTS. The TIB's capacity to identify the presence and contribution of negative interpretation bias with child trauma is an important contribution to the field and has implications for our understanding of the cognitive mechanisms underlying this disorder and treatment interventions such as CBM-I. Thus, this study provides some empirical support for cognitive models of child PTSD (Ehlers & Clark, 2000; Meiser-

Stedman, 2002) which have been largely supported by self-reported questionnaires of unhelpful beliefs (Meiser-Stedman, Smith, et al., 2009) not direct examination of interpretive biases per se.

The contribution of negative interpretation bias also accounted for later maladaptive cognitions and symptoms although this was modest when initial symptom severity was controlled (e.g., negative bias then accounted for 3% of PTS symptoms at 12-week follow-up). The proportion of variance appears minor in comparison with other known predictors of trauma symptoms (i.e., unhelpful beliefs, psychobiological factors, social support) (Hiller et al., 2018; Hitchcock, Ellis, Williamson, & Nixon, 2015; Nixon, Nehmy, et al., 2010). This raises questions as to whether negative interpretation biases have a strong influence on children's PTS. Or perhaps this small contribution was due to item specificity of the TIB measure used to index trauma-related biases. However, it should be remembered that the modest explanation of variance is also likely explained by (a) the relatively low level of symptoms in the overall sample, and (b) this was *after* initial symptom severity had been controlled.

My final goal in Study 1 was to examine if the TIB could be used identify children who may be at risk of developing later problems. This was not successful. That is, children who had low bias (and low symptoms) were as likely to experience clinical symptoms at follow up as those children who had initially reported a high level of bias and low symptoms. Yet, although the number of children was low (e.g., $n \leq 6$), the proportion of children with a high level of bias at baseline and then in the clinical range at follow up was in the expected direction, compared with children with a low level of bias at baseline and clinical level of symptoms at follow up (e.g., $n \leq 3$). My use of an unselected sample may have contributed to the low power of these analyses to detect significant differences due to the small number of children reporting a high level of bias in the absence of PTS symptoms. This was also likely compounded by the use of the 75th percentile threshold to allocate children to the high bias category to ensure sufficient numbers from the unselected sample, thus capturing children with a moderate to high level of bias rather than a high-extreme level of bias (e.g., compared with using a threshold of ≥ 90th percentile). That said, the methodology used in this study to examine the vulnerability of children for later problems (i.e., dichotomising the sample) resulted in possibly a less sensitive analysis. Subsequent correlational analyses (at the suggestion of an examiner) showed a significant association between children's negative bias level and follow up trauma symptoms, and although the correlation was small, this analysis suggests there was possibly a relationship between some of the variables of interest. The early identification of vulnerabilities for reducing children's later risk of psychopathology has been investigated in other areas. A study by Kuo, Vander Stoep, Herting, Grupp, and McCauley (2013) investigated school related predictors (i.e., school record data, grade, attendance, suspension, demographic information) for children screened at risk of depression. School-based information had low predictive value for identifying students at risk and was shown to better predict non-depressed individuals although the researchers suggested this null finding was impacted by the rate of student participation and access to quality data. Other research examined the predictive validity of externalising behaviours in young children at risk of conduct disorder and found when used in isolation, externalising behaviour symptoms led to the misclassification of children at risk (Bennett et al., 1999). Although the risk was heightened for children with these problem behaviours, it indicated that conduct disorder, like other psychological problems including posttraumatic stress, is associated with *numerous* risk factors (i.e., child/family/environment) (Kassam-Adams, Marsac, Hildenbrand, & Winston, 2013; Murray & Farrington, 2010; Trickey, Siddaway, Meiser-Stedman, Serpell, & Field, 2012). Taken together, these studies highlight the complexities that researchers may encounter in this domain of study. In sum, my research is a further example of the challenges in identifying children at risk of PTS (and general anxiety), an issue shared across all psychopathology research.

Despite the TIB measure having some shortcomings, Study 1 makes several important contributions to the child PTSD field. It represents the first attempt to create a measure that indexes threat interpretation bias in the context of ambiguous situations. The TIB showed some promising psychometric and validity properties (e.g., correlations with symptom measures), including moderate but not overly high correlation with a social anxiety focussed ambiguity measure (the AST). Future research would involve further scale refinement and development (i.e., item modification, the inclusion of open-ended interpretation response options and normative evaluation to establish an appropriate cut-off threshold) along with factor analyses and psychometric testing (i.e., discriminant validity, reliability analyses) (Shum, 2017; Tabachnick & Fidell, 1996) and replication. As will be discussed now, the second focus of my thesis examined the efficacy of CBM-I to modify children's threat-related interpretation biases and PTS symptoms.

The aim of Study 2 was to assess the effect of four positive CBM-I training sessions with an unselected sample of school children. Training effects were analysed with the whole sample and a clinical subset. Across the whole sample, training was effective in altering children's negative interpretations of social ambiguity which supports previous CBM-I investigations conducted with socially anxious children (Lau et al., 2013; Salemink & Wiers, 2011; Vassilopoulos et al., 2009). Training effects were also observed for positive biases associated with social ambiguity and anxiety symptoms when analysing the whole sample. Although I did not find widespread evidence of moderator effects which is consistent with previous meta-analyses (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017), CBM-I appeared to work better for older anxious children and for females when processing ambiguous social situations. There were no treatment effects in terms of children's negative trauma-related biases as measured by the TIB, which contrasts with findings from meta-analyses (Cristea, Mogoașe, et al., 2015; Krebs et al., 2017). This outcome may be partly explained by research that reported the transfer of CBM-I training effects only when both the training content and assessment items were matched (Mackintosh, et al., 2006). Although both the TIB items and CBM-I training trials featured threats which were relevant to PTSD sufferers, these themes were presented within a social context (i.e., school activities, peer interaction) rather than being trauma specific. Further, given the developmental level of most participants (i.e., concrete level of processing) it is possible the trauma relevance of the scenarios was not inferred (Berk, 2009). Further, the difference in findings may be also explained by the treatment dose which appeared adequate to facilitate change with social interpretation but less so with threat-related interpretations. Alternatively, the low level of endorsement for the negative threat-biases across the whole sample is suggestive of a floor effect whereby many children may have had limited room for change. The influence of treatment dose on CBM-I effects has been suggested by several researchers to account for null results across anxiety and depression CBM-I studies (Chan et al., 2015; Micco et al., 2014; Orchard et al., 2017; Salemink & Wiers, 2011) and therefore is relevant for both the present study and future research as detailed next.

The effect of CBM-I dose as well as understanding who might benefit favourably from smaller dose treatment has implications for future studies investigating optimal targeting of children in need. The four CBM-I sessions used in the current study was based upon the number of sessions reported to have induced biases and symptom change for social anxiety (Lau et al., 2013; Vassilopoulos et al., 2009). Although replication of my study is needed, the findings suggest that the universal application of CBM-I in its current form for threat-related interpretation bias associated with PTS would have limited benefit, although brief training may possibly further strengthen adaptive processing in children *not* currently showing an interpretation bias in social situations or not currently experiencing problematic anxiety (Lester et al., 2011a). Some studies have shown better CBM-I outcomes on interpretation biases and anxiety symptoms with more frequent training sessions conducted for a more prolonged period (Klein et al., 2015; Sportel et al., 2013). Thus, future research is needed to determine whether such changes in training would improve CBM-I effects for children with trauma–related interpretation biases and symptoms. In a sense, such an approach would be like traditional trauma-focused therapy for PTSD, leading to consolidation of learning through repetition and practise, important elements of the cognitive restructuring components of CBT (Cohen, Mannarino, Deblinger, & Berliner, 2009).

Unlike the few adult studies conducted to date by Woud et al. (2018; 2012; 2013) my research which is the first known investigation of CBM-I with child PTS symptoms produced mostly null results across the trauma measures. However, this result was unsurprising when analysing the whole sample, which exhibited low level biases and was generally functioning within the normal range. However, treatment effects were not observed for the subsample of children with a clinical level of trauma symptoms, nor did it have any preventative effect on children developing later symptoms. This outcome may have been influenced by several factors. These include: maturation effects, the immediacy and type of events children reported (many were deemed stressful but might have occurred many years previously and a number did not reach Criterion A status, i.e., serious life-threatening events to self or other), and the power of the study to detect change in subsamples that contained a small number of participants. In addition to the obvious difference in age, it is worth noting that change in adult participants' trauma-related appraisal biases and symptoms seen in the work of Woud and colleagues occurred in the context of recent exposure to an analogue trauma. Although replication of my studies is needed, the broader implication of these findings is that the CBM-I intervention may be less effective as a general preventative intervention. It is possible, with increased dose, it might be more suitable for use with children experiencing ongoing symptoms following trauma exposure. Thus, future CBM-I research may employ a more targeted approach with children experiencing PTS soon after trauma exposure to assess its effects for those in most need.

Several other factors may have contributed to the null results. CBM-I studies have shown children's acquisition of an adaptive bias style and reduction in symptoms may improve with the support of a significant other (e.g., parent and/or peer) (Cox et al., 2015; Lau et al., 2013; Reuland & Teachman, 2014; Vassilopoulos & Brouzos, 2016). Although no child sought assistance to complete the CBM-I exercises in the current study, this does not mean a child is not in need of support (Butler, 1998). Further, parental involvement in children's trauma recovery have been shown to play an important role. In some cases, unhelpful parenting responses (i.e., negative appraisal, overprotective parenting) following trauma exposure has led to poorer outcomes for the child (Hiller et al., 2018). In contrast, adaptive support from significant others (i.e., parent/grandparent, sibling) may improve children's post-trauma functioning whether that is through natural recovery processes (Hitchcock et al., 2015), via formal PTSD treatment such as TF-CBT (Cohen & Mannarino, 2008), or through enhancing children's learning within the classroom (Castro et al., 2015). This suggests that the inclusion of caregivers in children's treatment may significantly improve outcomes for the child. It remains an empirical question whether involvement of significant others in CBM-I, especially for younger children who might benefit most from such support (vs adolescents), may lead to the augmentation of its effects as well as generalisation of learning. However, it is entirely possible my null findings are an accurate reflection of the ineffectiveness of CBM-I in these samples or that the intervention may only work for children who are able to achieve meaningful attribution change, consistent with research that has suggested a change in symptoms cannot be achieved without a change in attribution bias (Clarke et al., 2014; Grafton et al., 2017).

Consistent with previous research, I did observe significant improvement in children's positive mood state (e.g., happiness) immediately following CBM-I training (Lothmann et al., 2011). This suggests that training children to interpret threat-related ambiguous events in a benign way has the potential to influence their emotional wellbeing. According to Fredrickson's (2001) broaden and build theory of positive emotions, feeling positive emotions may lead to an expansion of thoughts and actions that improve an individual's ability to take on new information and experiences. The promotion of positive emotion to build adaptive cognitive processing may be particularly important for children with PTS who experience both negative alteration in cognition and affect (Meiser-Stedman, 2002). Therefore, future research could examine the role of CBM-I on accentuating positive emotions which might in turn improve information processing (as indicated by Fredrickson, 2001).

Although the benefit of CBM-I with this community sample was not realised, the ease of delivery and accessibility to end users suggest, with further development that results in demonstrated efficacy, this type of intervention could help supplement current unmet need in developing children's capacity following stressful events. Replication of the study is needed to verify its potential benefit with non-clinical samples, however my initial work delivering CBM-I to a non-clinical sample represents the first step in understanding the potential benefit of this cost-effective training model and its potential use with child trauma populations.

Building on the school-based research, I conducted a pilot study to assess the efficacy of the CBM-I intervention with a clinical sample of children with PTS following accidental injury. Although unforeseen circumstances prevented comparative analyses between groups (i.e., significant attrition of controls), some evidence of change in children's threat-related interpretation bias was observed following three positive training sessions but this did not translate to a reduction in trauma related or anxiety symptoms. These findings are consistent with clinical anxiety research using brief CBM-I (Orchard et al., 2017; White et al., 2016) but not with others (Lau et al., 2013; Reuland & Teachman, 2014; Vassilopoulos et al., 2009) although in the absence of controls it is unclear what may have led to changes that occurred. That said, considering other clinical research that has demonstrated CBM-I effects on symptoms following extended training (Klein et al., 2015; Sportel et al., 2013), as with study 2, the issue of dose needs to be addressed.

However, there was also some evidence of natural recovery occurring for some participants. This is indeed the norm following trauma exposure (Le Brocque et al., 2010) and has implications about the optimal timing of when to administer a CBM-I intervention. This is particularly important in light of the findings with psychological debriefing research with traumatised adult samples that has shown debriefing is at best ineffective, and at worst, possibly harmful (McNally, Bryant, & Ehlers, 2003). Longitudinal studies show that children are more likely to report a high level of symptoms immediately post trauma (e.g., at 1 month) but most (approximately 90%) show recovery at around 3 months (Kassam-Adams & Winston, 2004; Le Brocque et al., 2010). In addition, when examining the trajectory of children's recovery post accidental injury, Le Brocque and colleagues did not find any evidence of delayed onset of PTS at 6 months. My study comprised an acute sample who were showing elevated PTS when recruited 4 to 6-weeks post-trauma. Although a sufficient period of time had elapsed for most children to have shown natural recovery, and children entered into the study were still displaying significant symptoms and probably were at risk of continued difficulties, some children might have continued to recover regardless of formal intervention. This suggests that research needs to identify the best possible timeframe in which to assess the eligibility of children for treatment like CBM-I. In contrast, although unavoidable, some children in the current study were still undergoing medical procedures during the CBM-I intervention, which in some cases might have reduced the impact of the intervention. Relevant to my sample, Kenardy and colleagues evaluated the efficacy of a psychoeducation intervention aimed at normalising and reducing children's trauma reactions following recent accidental injury (Kenardy et al., 2015). They observed that children's high level of initial distress moderated treatment effects, with more symptomatic children benefiting most from the intervention. Taken together, these studies suggest future research needs to examine how to best monitor children's symptoms levels during this acute phase and how to determine when (or if) a CBM-I intervention could be commenced, taking into account the complicating factor that some children may still be undergoing medical treatment.

Study 3 addressed PTS from recent trauma. The potential efficacy of CBM-I for children with PTSD (i.e., more chronic PTS) is yet unknown. As discussed previously, many children do well with current evidence-based treatments (e.g., Trauma-Focussed Cognitive Behavioural Therapy) but some do not, and not all families have access to specialist services (Anderson et al., 2017). Investigations that have examined the effect of a combination of interpretation and attention bias training as a standalone intervention alongside CBT have shown both treatments can lead to a reduction in children's bias cognition and social anxiety symptoms (de Hullu et al., 2016; Sportel et al., 2013). In addition, a study with an adult trauma sample found that, as an adjunct to standard trauma based treatment (i.e., CBT and pharmacology), participants who completed the Attention Bias Modification training (i.e., training attention away from threat) experienced a significant reduction in trauma and depression symptoms relative to controls (i.e., training attention away from neutral stimuli) and individuals who received standard care (Kuckertz et al., 2014). Although it was beyond the scope of the current study to test combined modification trainings, and whether such interventions work better as adjunctive interventions or as stand-alone interventions for children with PTSD, these preliminary studies and my own research suggest testing of CMB-I use as an adjunct and/or standalone intervention for children with PTSD maybe a fruitful avenue for future research.

Conclusion

Summing up my program of research conducted across three studies, I have shown that negative threat-related interpretation biases are exhibited by children who have been exposed to stressful or traumatic events in both unselected and clinical populations. These findings are significant because they represent the first attempt to document such biases in child trauma samples explicitly by means other than a self-report questionnaire. They add to our knowledge of children's cognitive processing and illustrate that these biases, which have generally been examined in childhood anxiety broadly, are also present in children with PTS symptoms. The findings add further support to cognitive models of PTSD, in particular the hypothesised underlying mechanisms that have been argued to be critical to the development and maintenance of this disorder (e.g., Ehlers & Clark, 2000; Meiser-Stedman, 2002).

Although the intervention studies of Study 2 and 3 that examined the efficacy of positive CBM-I produced mostly null findings, the testing of the CBM-I approach with unselected and clinical samples has helped to advance the field in several ways. This includes replication of previous research that systematic CBM-I training can alter children's interpretation of *social* biases and can lead to symptom reduction in anxiety in an unselected sample, and the novel contribution that CBM-I can result in a reduction in *threat-related* biases for children with clinical level of trauma symptoms. In response to the paucity of CBM-I research in trauma samples, an emerging area of research, my PhD developed a training program and tested its capacity to modify children's trauma-related biases and symptoms and examined under what conditions it may successfully operate. Although this approach largely did not produce the expected results, it represents a starting point for future CBM-I research for children with PTS. Similarly, the extended assessment and follow-up periods of the studies were an improvement on previous research and enabled the exploration of the longer-term effects of CBM-I training on children's interpretation biases and symptoms which has important practical implications for the utility of the approach. Although more empirical work is clearly needed, the results of the research suggested that the intervention was acceptable to children, their caregivers, and school educators. As discussed previously, future studies will help determine the optimal conditions for CBM-I efficacy, and whether it may have targeted or universal applications as a school-based intervention to promote the wellbeing of children following negative and traumatic events. In closing, it is hoped continued research in this area will lead to more effective treatment for the many children affected by trauma and by doing so, improve the quality of life and wellbeing for these most important members of our society.

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Appendix A

Study 1 Test of Interpretive Bias Form A 12-item dichotomous format

Table S1 Test of Interpretive Bias Form A 12-item dichotomous format

Test of Interpretive Bias- 1		
The following is a list of situations children can experience. Please read each item carefully, and then pick one answer that best describes your thinking if this was happening to you. People understand situations in many different ways. There are no right or wrong answers.		
1. You are trying something new, so you need extra time to complete the task. You think taking extra time means…	□ I am concentrating	□ I am dumb
2. An item has been stolen from your school bag or locker. This means you should …	□ Not trust anyone	□ Not leave valuables in your bag or locker
3. You are in a school play and forget your line but manage to say something. You think I must be …	□ Smart because I came up with something to say	□ Stupid because I forgot my line
4. You are at a birthday party and playing pass the parcel. You don't get to open any wrappers. This means it must be …	□ My fault	□ Out of my control
5. You are at the swimming pool. As you make your way to the water you are closely watching to see if other kids are staring at you. Being alert is…	□ Unhelpful	□ Helpful
6. Your family has to move, but you like where you live. You think about the new house as something to…	□ Dread	□ Accept
7. It is your birthday and you get some nice presents, but you don't get the gift you really want. This means …	□ There must be a good reason	□ People don't really care.
8. You have been asked to do something new and notice some reactions within your body. You have felt this before and recognise it as feelings of …	□ Fear	□ Excitement
9. You are watching a movie and the story feels real to you, as if it is happening now, even though it is not. You think your reactions are…	□ Sometimes mistaken	□ Always correct
10. People experience different feelings. Sometimes you can feel happy, sad or irritable, then angry. Having different feelings that change means you are…	□ Crazy	□ Normal
11. It is the start of the new school year. You want to be in the middle class for a subject but have been put in the bottom class. You think this means…	□ I'll have to work harder	□ I'm not smart enough
12. You have to now wear glasses. You look different than you did before and think…	□ I'll never be the same	□ I'll get used to it

Appendix B

Study 1 Test of Interpretive Bias Form B 12-item dichotomous format

Table S2 Test of Interpretative Bias Form B 12-item dichotomous format

Test of Interpretive Bias- 2		
The following is a list of situations that children can experience. Please read each item carefully, and then pick *one* answer that best describes your thinking if this was happening to you. People understand situations in many different ways. There are no right or wrong answers.		
1. A friend asked to borrow your favourite pen but didn't give it back then lost it. The friend offered to buy you another pen. You think …	□ People let me down	□ A new pen would be good
2. You haven't got a mobile phone and don't feel as good as your friends. You tell yourself …	□ It is wrong to think this way	□ It is ok to think this way
3. You enjoy the concert and accidentally clap before it ends, people look at you. You feel your face going red and hot and think people will…	□ Think I am stupid	□ Soon forget it happened
4. You are playing an online game with other kids. Your character is losing. This is because …	□ Of something out of my control	□ I am a bad player
5. Something unexpected happened as you walked into the classroom. You think…	□ I should always be ready	□ It is unlikely to happen again
6. You have made plans to go on holiday, but because of bad weather you can't go. You think this means your trip is …	□ Delayed	□ Spoilt
7. Children sometimes need help to do things. You think getting help when it is needed means you are… …	□ Weak	□ Sensible
8. You're at the zoo and as you walk by the cage the lion roars. You are not in any *real* danger, but your body reacts as if you are. You think your reactions are…	□ Sometimes wrong	□ Always correct
9. You forget about casual clothes day and turn up to school in your uniform. You notice other children watching you as you walk in and think they are looking at me because…	□ I don't fit in	□ People like to see who has arrived at school
10. You see some money on the ground and go to pick it up. You realise the money has been glued and the kids behind you begin to laugh. You think…	□ Anyone could have been tricked	□ This is the worst thing ever
11. You know the answer to a question and call out in class. The teacher looks your way but chooses someone else. You wished you had waited and think…	□ I got the answer right	□ I always do the wrong thing
12. Someone has posted a photo of you on Facebook. You don't want kids at school to see or discuss it. The photo means your reputation/ future is...	□ Damaged	□ OK

Appendix C

Study 1 Test of Interpretive Bias Form A 12-item Likert format

Table S3 Test of Interpretive Bias Form A 12-item Likert

We would like to know how you think about some everyday situations. Each situation below is followed by two ways you might think about the situation. Imagine the situation happening to you. For the two ways you might think about the situation, tell us how much you **AGREE or DISAGREE** by marking a response for each statement. People think about situations in different ways. There is no right or wrong answers to these statements.

1. You are trying something new, so you need extra time to complete the task. You think taking extra time means....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I am concentrating	○	○	○	○
I am dumb	○	○	○	○
2. An item has been stolen from your school bag or locker. This means you should....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Not trust anyone	○	○	○	○
Not leave valuables in your bag or locker	○	○	○	○
3. You are in the school play and forget your line but manage to say something. You think I must be....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Smart because I came up with something to say	○	○	○	○
Stupid because I forgot my line	○	○	○	○
4. You are at a birthday party and playing pass the parcel. You don't get to open any wrappers. This means it must be....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
My fault	○	○	○	○
Out of my control	○	○	○	○
5. You are at the swimming pool. As you make your way to the water you are closely watching to see if other kids are staring at you. Being alert is...				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Helpful	○	○	○	○
Unhelpful	○	○	○	○
6. Your family has to move, but you like where you live. You think about the new house as something to…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Dread	○	○	○	○
Accept	○	○	○	○

7. Children sometimes need help to do things. You think getting help when it is needed means you are…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Weak	○	○	○	○
Sensible	○	○	○	○
8. You are at the zoo as you walk by the cage the lion roars. You are not in any real danger but your body reacts as if you are. You think your reactions are…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Sometimes wrong	○	○	○	○
Always correct	○	○	○	○
9. You forget about casual clothes day and turn up to school in your school uniform. You notice other children watching as you walk in. They are looking at me because…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I don't fit in	○	○	○	○
People like to see who has arrived at school.	○	○	○	○
10. You see some money on the ground and go to pick it up. You realise the money has been glued and the kids behind you begin to laugh. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Anyone could have been tricked	○	○	○	○
This is the worst thing ever	○	○	○	○
11. You know the answer to a question and call out in class. The teacher looks your way but chooses someone else. You wish you had waited but think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I got the answer right	○	○	○	○
I always do the wrong thing	○	○	○	○
12. Someone has posted a photo of you on Facebook. You don't want the kids at school to see it or discuss it. The photo means your future and reputation is …				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Damaged	○	○	○	○
Ok	○	○	○	○

Appendix D

Study 1 Test of Interpretive Bias Form B 12-item Likert format

Table S4 Test of Interpretive Bias Form B 12-item Likert

We would like to know how you think about some everyday situations. Each situation below is followed by two ways you might think about the situation. Imagine the situation happening to you. For the two ways you might think about the situation, tell us how much you **AGREE or DISAGREE** by marking a response for each statement. People think about situations in different ways. There is no right or wrong answers to these statements.

1. A friend asked to borrow your favourite pen but didn't give it back then lost it. The friend offered to buy you another pen. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
People let me down	○	○	○	○
A new pen would be good	○	○	○	○
2. You haven't got a mobile phone and don't feel as good as your friends. You tell yourself…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
It is wrong to think this way	○	○	○	○
It is ok to think this way	○	○	○	○
3. You enjoy the concert and accidentally clap before it ends, people look at you. You feel your face going red and hot and think people will…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Think I am stupid	○	○	○	○
Soon forget it happened	○	○	○	○
4. You are playing an online game with other kids. Your character is losing. This is because …				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Of something out of my control	○	○	○	○
I am a bad player	○	○	○	○
5. Something unexpected happened as you walked into the classroom. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I should always be ready	○	○	○	○
It is unlikely to happen again	○	○	○	○
6. You have made plans to go on holiday but because of bad weather you can't go. You think this means you trip is …				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Delayed	○	○	○	○
Spoilt	○	○	○	○

	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
7. Children sometimes need help to do things. You think getting help when it is needed means you are…				
Weak	○	○	○	○
Sensible	○	○	○	○
8. You are at the zoo as you walk by the cage the lion roars. You are not in any real danger but your body reacts as if you are. You think your reactions are…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Sometimes wrong	○	○	○	○
Always correct	○	○	○	○
9. You forget about casual clothes day and turn up to school in your school uniform. You notice other children watching as you walk in. They are looking at me because…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I don't fit in	○	○	○	○
People like to see who has arrived at school.	○	○	○	○
10. You see some money on the ground and go to pick it up. You realise the money has been glued and the kids behind you begin to laugh. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Anyone could have been tricked	○	○	○	○
This is the worst thing ever	○	○	○	○
11. You know the answer to a question and call out in class. The teacher looks your way but chooses someone else. You wish you had waited but think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I got the answer right	○	○	○	○
I always do the wrong thing	○	○	○	○
12. Someone has posted a photo of you on Facebook. You don't want the kids at school to see it or discuss it. The photo means your future and reputation is …				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Damaged	○	○	○	○
Ok	○	○	○	○

Appendix E

Study 3 Test of Interpretive Bias 24-item Likert format

Table S5 Test of Interpretive Bias 24-item

We would like to know how you think about some everyday situations. Each situation below is followed by two ways you might think about the situation. Imagine the situation happening to you. For the two ways you might think about the situation, tell us how much you **AGREE or DISAGREE** by marking a response for each statement. People think about situations in different ways. There is no right or wrong answers to these statements.

1. You are trying something new, so you need extra time to complete the task. You think taking extra time means....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I am concentrating	○	○	○	○
I am dumb	○	○	○	○
2. A friend asked to borrow your favourite pen but didn't give it back then lost it. The friend offered to buy you another pen. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
People let me down	○	○	○	○
A new pen would be good	○	○	○	○
3. An item has been stolen from your school bag or locker. This means you should....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Not trust anyone	○	○	○	○
Not leave valuables in your bag or locker	○	○	○	○
4. You haven't got a mobile phone and don't feel as good as your friends. You tell yourself…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
It is wrong to think this way	○	○	○	○
It is ok to think this way	○	○	○	○
5. You are in the school play and forget your line but manage to say something. You think I must be....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Smart because I came up with something to say	○	○	○	○
Stupid because I forgot my line	○	○	○	○

6. You enjoy the concert and accidentally clap before it ends, people look at you. You feel your face going red and hot and think people will…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Think I am stupid	○	○	○	○
Soon forget it happened	○	○	○	○
7. You are at a birthday party and playing pass the parcel. You don't get to open any wrappers. This means it must be....				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
My fault	○	○	○	○
Out of my control	○	○	○	○
8. You are playing an online game with other kids. Your character is losing. This is because…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Of something out of my control	○	○	○	○
I am a bad player	○	○	○	○
9. You are at the swimming pool. As you make your way to the water you are closely watching to see if other kids are staring at you. Being alert is...				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Helpful	○	○	○	○
Unhelpful	○	○	○	○
10. Something unexpected happened as you walked into the classroom. You think…				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I should always be ready	○	○	○	○
It is unlikely to happen again	○	○	○	○
11. Your family has to move, but you like where you live. You think about the new house as something to...				
	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Dread	○	○	○	○
Accept	○	○	○	○

	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
12. You have made plans to go on holiday but because of bad weather you can't go. You think this means you trip is …				
Delayed	○	○	○	○
Spoilt	○	○	○	○
13. It is your birthday and you get some nice presents, but you don't get the gift you really want. This means...	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
There must be a good reason	○	○	○	○
People don't really care	○	○	○	○
14. Children sometimes need help to do things. You think getting help when it is needed means you are…	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Weak	○	○	○	○
Sensible	○	○	○	○
15. You have been asked to do something new and begin to notice some reactions within your body. You recognise it as feelings of...	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Fear	○	○	○	○
Excitement	○	○	○	○
16. You are at the zoo as you walk by the cage the lion roars. You are not in any real danger, but your body reacts as if you are. You think your reactions are…	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Sometimes wrong	○	○	○	○
Always correct	○	○	○	○
17. You are watching a movie and the story feels real to you, as if it is happening now, even though it is not. You think your reactions are…	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Sometimes mistaken	○	○	○	○
Always correct	○	○	○	○

	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
18. You forget about casual clothes day and turn up to school in your school uniform. You notice other children watching as you walk in. They are looking at me because…				
I don't fit in	○	○	○	○
People like to see who has arrived at school.	○	○	○	○
19. People experience different feelings. Sometimes you can feel happy, sad or irritable then angry. Having different feelings that change means you are...	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Normal	○	○	○	○
Crazy	○	○	○	○
20. You see some money on the ground and go to pick it up. You realise the money has been glued and the kids behind you begin to laugh. You think…	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Anyone could have been tricked	○	○	○	○
This is the worst thing ever	○	○	○	○
21. It is the start of the new school year. You want to be in the middle class for a subject but have been put in the bottom class. You think this means....	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I'm not smart enough	○	○	○	○
I'll have to work harder	○	○	○	○
22. You know the answer to a question and call out in class. The teacher looks your way but chooses someone else. You wish you had waited but think…	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I got the answer right	○	○	○	○
I always do the wrong thing	○	○	○	○
23. You have to now wear glasses. You look different than you did before and think...	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
I'll get used to it	○	○	○	○
I'll never be the same	○	○	○	○
24. Someone has posted a photo of you on Facebook. You don't want the kids at school to see it or discuss it. The photo means your future and reputation is …	Disagree a lot	Disagree a bit	Agree a bit	Agree a lot
Damaged	○	○	○	○
Ok	○	○	○	○

Appendix F

Study 1 Correlations between the Test of Interpretive Bias and outcome measures

Table S6 Bivariate correlations between measures of baseline trauma symptoms, cognitions and affect, and the Test of Interpretive Bias negative and positive scales with the dichotomous and Likert type style scoring formats.

	CPSS	cPTCI	BAI-Y	CDI-S
Test of Interpretive Bias				
Negative Scale				
TIB-12Di (n=145)	.18*	.14	.15	.22**
TIB-12Li (n=36)	.65**	.68**	.46**	.50**
TIB- 24 (n=359)	.43**	.55**	.50**	.50**
Positive Scale				
TIB-12Di (n=144)	-.18*	-.14	-.15	-.21*
TIB-12Li (n=36)	-.19	-.28	-.06	-.34*
TIB- 24Di (n=359)	-.25**	-.29**	-.28**	-.34**

Note: TIB = Test of Interpretive Bias; TIB -12Di = Test of Interpretive Bias 12-item Dichotomous format; TIB-12 Li = Test of Interpretive Bias 12-item Likert-style; TIB-24Li: =Test of Interpretive Bias-negative scale 24-item Likert format; CPSS= Child Posttraumatic Symptom Scale; cPTCI= child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory- Youth; CDI-S = Child Depression Inventory-Short Form.

*p < .05, **p <.001

Appendix G

Study 1-3 Test of Interpretive Bias negative and positive scale Z-scores

Table S7 Subsample Z-score means and standard deviations of the Test of Interpretive Bias negative and positive scales.

	Negative scale Z-score		Positive scale Z-score	
Test of Interpretive Bias	*n*	*M (SD)*	*n*	*M (SD)*
12 - Item Dichotomous	144	2.63 (1.50)	144	9.36 (1.50)
12 - Item Likert	37	15.41(5.35)	38	24.16 (4.34)
24 - Item Likert	370	29.34 (10.71)	369	47.84 (8.21)

Appendix H

Study 2 Combined sample schools' Z-score of socioeconomic bands using the ICSEA

Table S8 Combined study sample; Recruited South Australian schools' Z-score of socioeconomic bands as measured by the Index of Community Socio-Educational Advantage (ICSEA)

Schools (N =12)	ICSEA score	Mean	SD	Z-score
2.1	923	1003	88.11459	-0.907909
2.2	1075	1003	88.11459	0.8171178
2.3	919	1003	88.11459	-0.953304
2.4	1002	1003	88.11459	-0.011349
2.5	949	1003	88.11459	-0.612838
2.6	987	1003	88.11459	-0.181582
3.1	893	1003	88.11459	-1.248374
3.2	1014	1003	88.11459	0.1248374
3.3	910	1003	88.11459	-1.055444
3.4	1128	1003	88.11459	1.4186072
3.5	1136	1003	88.11459	1.5093981
3.6	1100	1003	88.11459	1.1008392
Total Index	12036			
Mean	1003			
SD	88.11459			

Notes; School Index with a *M* of 1000 and *SD* 100 (higher scores reflect higher advantage); 2.1= Regional public; 2.2 = Metropolitan public; 2.3= Regional public; 2.4= Regional private; 2.5 = Regional public; 2.6 =Metropolitan public (high school); 3.1= Regional public; 3.2= Regional private; 3.3= Regional public; 3.4= Metropolitan public; 3.5 = Metropolitan public; 3.6 =Metropolitan private.

Appendix I

Study 1 and Study 2 recruited schools' *Z*-score of socioeconomic bands using the ICSEA

Table S9: Study 1 sample: Recruited schools' *Z*-score of socioeconomic bands as measured by the Index of Community Socio-Educational Advantage (ICSEA).

School (N=6) (redacted)	ICSEA score	Mean	SD	Z-score
2.1	923	975	58.97	-0.8818
2.2	1075	975	58.97	1.695778
2.3	919	975	58.97	-0.94964
2.4	1002	975	58.97	0.45786
2.5	949	975	58.97	-0.4409
2.6	987	975	58.97	0.203493
Total Index	5855			
Mean	975.83			
SD	58.97			

Notes; School Index with a *M* of 1000 and *SD* 100 (higher scores reflect higher advantage); 2.1= Regional public; 2.2 = Metropolitan public; 2.3 = Regional public; 2.4 = Regional private; 2.5 = Regional public; 2.6 =Metropolitan public (high school).

Table S10: Study 2 sample: Recruited schools' *Z*-score of socioeconomic bands as measured by the Index of Community Socio-Educational Advantage (ICSEA).

School (N=6) (redacted)	ICSEA score	Mean	SD	Z-score
3.1	893	1030	108.78	893
3.2	1014	1030	108.78	1014
3.3	910	1030	108.78	910
3.4	1128	1030	108.78	1128
3.5	1136	1030	108.78	1136
3.6	1100	1030	108.78	1100
Total Index	6181			
Mean	1030.16			
SD	108.78			

Notes; School Index with a *M* of 1000 and *SD* 100 (higher scores reflect higher advantage); 3.1 = Regional public; 3.2 = Regional private; 3.3 = Regional public; 3.4 = Metropolitan public; 3.5 = Metropolitan public; 3.6 = Metropolitan private.

Appendix J

Study 1 Baseline score difference on the maladaptive cognition and anxiety outcome measures for study samples 1 and 2

Table S11.

Means, Standard Deviation, Confidence Intervals and score differences on the baseline maladaptive cognition (cPTCI) and anxiety (BAI-Y) outcome measures for the two study samples

Outcome Variable	Sample Group	(N)	Mean (SD)	CL LL to UL	Sample score difference
Maladaptive cognition (cPTCI)					
	Sample 1	N = 175	39.8 (12.8)	37.95 to 44.79	
	Sample 2	N = 367	45.2 (15.5)	43.65 to 46.85	
					5.4**
Anxiety (BAI-Y)[a]					
	Sample 1	N = 175	48.8 (11.8)	47.06 to 50.60	
	Sample 2	N = 367	52.1 (14.2)	50.71 to 56.64	
					3.3**

Note: CL= confidence intervals; LL= lower limit, UL upper limit; cPTCI – Child Posttraumatic Cognitions Inventory; BAI-Y= Beck Anxiety Inventory- Youth, [a] T-score means are reported. ***p* <.001

An ANOVA was conducted to examine the mean score difference between the two samples on each outcome measure. Analyses indicated a significant mean score difference between the two study samples on the maladaptive appraisal $F(1,540) = 15.79$, $p < .001$, $\eta^2 = .36$ and anxiety, F (1,540) = 7.24, p =.007, $\eta^2 = .24$ scales. The outcome means across the sample groups fell within the normal range of functioning on each outcome measure as indicated by the small effect size. The actual score differences between means on the maladaptive cognition (i.e. a 5-point difference) and anxiety (i.e. 3-point difference) measures are minimal when the scale of each measure is considered (i.e. doesn't move someone from being average endorsing a 'don't agree a bit' to 'agree a bit': - maladaptive cognition and 'sometimes' to 'often': - anxiety).

Appendix K

Studies 1 and 2, Percentage of participants above the clinical cut-off on the outcome measures.

Table S12.

Percentage of participants in samples 1 and 2 above the clinical cut-off on the trauma, maladaptive cognition, anxiety, and depression outcome measures.

Outcome measure	Cut-off	Sample 1(N=178)	Sample 2 (N=395)	Total (N=585)
Trauma (CPSS)	≥ 24	24% (*n* = 42)	32% (*n* = 116)	29% (*n* = 158)
Cognition (cPTCI)	≥ 50	21 % (*n* = 37)	36% (*n* = 133)	31% (*n* = 170)
Anxiety (BAI-Y)	≥ 70	9% (*n* = 15)	14% (*n* = 52)	12% (*n* = 67)
Depression (CDI-S)	≥ 70	7% (*n* = 12)	9% (*n* = 32)	8% (*n* = 44)

Note. CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory-Youth; CDI-S = Children's Depression Inventory – Short Form

Appendix L

Studies 1 & 2 Trauma event analyses on the Test of Interpretive Bias and the trauma outcome measure

Table S13 Trauma event analyses the Test of Interpretive Bias and trauma outcome measure

Analysis Type	Sample-with all event items	Sample excludes non-stressful events	Sample excludes blank/unclear events
Correlations	N = 536	N = 527	N = 475
Negative bias (TIB)/ Trauma (CPSS)	.379	.380	.393
Positive bias (TIB)/ Trauma (CPSS)	-.224	-.216	-.226
Frequencies	N = 585	N = 189	N = 187
Valid		N = 178	N = 176
Missing		11	11
Event item blank/unclear		-	22
Non-stress events		2	-
Other trauma events		176	154
	Proportion of participants moving from the normal to the trauma clinical range at follow up		
Chi Square	*N* = 68 (FU)	*N* = 68 (FU)	*N* = 63 (FU)
Baseline normal/clinical	35 / 3 (7.9%)	35 / 3 (7.9%)	34 / 3 (8.1%)
12 weeks Follow-Up normal/clinical	24 / 6 (20%)	24 / 6 (20%)	21 / 5 (19.2%)
	χ^2 = 2.139	χ^2= 2.139	χ^2 = 1.704
	p =.169	*p* =.169	*p* = *.257*
	Phi = .177	Phi = .177	Phi = .164
Magnitude of effect	Small to medium	Small to medium	Small to medium
	Linear regression predicting CPSS severity at follow up after controlling for various covariates		
Linear Regression	N=179	N=176	N =154
	(FU CPSS *n* = 160)	(FU CPSS *n* = 160)	(FU CPSS *n* = 131)
(1) School, age, sex	n.s	n.s	n.s
(2) Negative bias (TIB)	TIB neg ΔR^2 8%	TIB neg ΔR^2 8%	TIB neg ΔR^2 7%
	p < .001	*p* <.001	*p* =.002
(1) School,age,sex,trauma (CPSS)	3 + CPSS ΔR^2 25%	3 + CPSS ΔR^2 26%	3 + CPSS ΔR^2 25%
	p < .001	*p* < .001	*p* < .001
(2) Negative bias (TIB)	TIB neg ΔR^2 2.4%	TIB neg ΔR^2 2.4%	TIB neg ΔR^2 2%
	p = .03	*p* =.03	*p* =.083
	Amount of variance accounted for on the CPSS by covariates		
Logistical Regression	N = 178	N = 176	N = 154
(1) School,age,sex	n.s	n.s	n.s
	Block 2 - χ^2 =10.18	Block 2 - χ^2= 10.18	Block 2 - χ^2 =10.47
(2) School,age,sex,Negative bias(TIB)	*p* = .04	*p* = .03	*p* =.03
Observed	133 (normal)	131 (normal)	115 (normal)
	39 (clinical)	39 (clinical)	32 (clinical)
Predicted	3 norm (clinical)	3 norm (clinical)	4 norm (clinical)
	3 clinical 7% (clinical)	3 clinical 7% (clinical)	3 clinical 8.6% (clinical)
Overall percentage	76%	76%	76.6%
Nagelkerke (variation in CPSS explained by the model)	.084	.084	.10
Significant variable in equation	TIB neg *p* =.007	TIB neg *p* =.006	TIB neg *p* =.014

Note. CPSS= Child Posttraumatic Symptom Scale; TIB = Test of Interpretive Bias; Magnitude of Effect Size: Cramer's V/Phi/ Cohen's *d*: Small = 0.1; 0.2, Medium = 0.3; 0.5, Large = 0.5; 0.8

Appendix M

Study 1 Logistical regression analysis for the Ambiguous Situations Test

Table S14

Logistical regression of trauma, maladaptive cognition, anxiety and depression outcome measures as a function of gender, age school index and the Ambiguous Situations Test negative interpretation bias variable.

	Trauma (CPSS)					95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL
ender	0.05	0.37	0.02	.89	1.05	0.51	2.18
Age in years	-0.11	0.11	1.06	.30	0.89	0.73	1.11
School Index	-0.24	0.21	1.37	.24	0.79	0.53	1.18
Negative bias	0.60	0.20	8.97	.00	1.83	1.23	2.71
Constant	0.03	1.23	0.00	.98	1.03		
	Maladaptive Cognition (cPTCI)					95% CI for OR	
Gender	0.38	0.40	0.89	.35	1.46	0.66	3.20
Age in years	-0.04	0.12	0.14	.71	0.96	0.77	1.20
School Index	-0.53	0.23	5.36	.02	0.59	0.38	0.92
Negative bias	0.60	0.22	7.71	.01	1.83	1.19	2.79
Constant	-1.01	1.32	0.59	.44	0.36		
	Anxiety (BAI-Y)					95% CI for OR	
Gender	0.77	0.42	3.40	.06	2.17	0.95	4.94
Age in years	0.12	0.12	1.00	.32	1.13	0.95	1.44
School Index	-0.12	0.23	0.28	.60	0.88	0.52	1.39
Negative bias	0.47	0.22	4.65	.03	1.61	1.01	2.47
Constant	-3.35	1.47	5.19	.02	0.04		
	Depression (CDI-S)					95% CI for OR	
Gender	0.73	0.45	2.67	.10	2.08	0.86	5.01
Age in years	-0.03	0.13	0.06	.81	0.97	0.76	1.24
School Index	-0.49	0.25	3.81	.05	0.61	0.37	1.00
Negative bias	0.68	0.24	8.08	.00	1.98	1.24	3.17
Constant	-1.71	1.46	1.37	.24	0.18		

Note. CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory-Youth; CDI-S = Children's Depression Inventory – Short Form.

Appendix N

Study 1. Test–retest reliability correlations for the bias and outcome measures

Table S15

Test-retest reliability correlations for the Test of Interpretive Bias and Ambiguous Situations Test and the trauma, maladaptive cognition, anxiety and depression outcome measures.

Outcome Measure	Baseline to Post (2weeks)	Baseline to Follow up (12 weeks)	Post (2 weeks) to Follow up (12 weeks)
TIB 12item Dichotomous			
Negative scale	.62** (n = 124)	.54** (n = 119)	.54** (n = 113)
Positive scale	.61** (n = 124)	.53** (n = 119)	.55** (n = 113)
TIB 12 item Likert			
Negative scale	.67** (n = 32)	.76** (n = 33)	.69** (n = 32)
Positive scale	.69** (n = 32)	.78** (n = 33)	.73** (n = 32)
TIB 24 item Likert			
Negative scale	.63** (n = 159)	.55** (n = 155)	.58** (n = 145)
Positive scale	.63** (n = 159)	.54** (n = 155)	.58** (n = 145)
AST			
Negative scale	.63** (n = 158)	.51** (n = 151)	.60** (n = 139)
Positive scale	.60** (n = 158)	.52** (n = 151)	.70** (n = 139)
CPSS	.71** (n = 158)	.50** (n = 152)	.54** (n = 143)
cPTCI	.74** (n = 155)	.58** (n = 159)	.65** (n = 143)
BAI-Y	.76** (n =155)	.60** (n = 150)	.65** (n = 144)
CDI-S	.73** (n = 155)	.73** (n = 148)	.80** (n = 142)

Note: TIB =Test of Interpretive Bias; AST = Ambiguous Situations Test; CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y= Beck Anxiety Inventory – youth; CDI-S= Children's Depression Inventory – Short Form.

**$p < .01$

Appendix O

Study 1 Hierarchical regression analysis of trauma symptoms with demographic and negative interpretation bias predictors

Table S16

Summary of hierarchical regression analysis of trauma symptoms (CPSS) with gender, age, school index, baseline trauma symptoms (T1), negative interpretation bias as predictor variables

Predictors	B	S.E.*B*	*β*	ΔR^2	Adjusted R^2	Multiple *R*	Overall *F*
Step 1				.262	.242	.262	*F*(4,147) = 13.03***
Gender	.526	1.519	.025				
Age	-.453	.443	-.075				
School index	-1.07	.837	-.096				
Trauma (T1)	.492	.074	.482***				
Step 2				.022	.260	.284	*F*(5,146) = 11.60***
Gender	1.092	1.524	.051				
Age	-.488	.438	-.081				
School index	-1.111	.827	-.100				
Trauma (T1)	.443	.076	.434***				
Negative interpretation bias	1.708	.798	.159*				

Note. CPSS = Child Posttraumatic Symptom Scale

*p < .05 ***p < .001

Appendix P

Study 1 Hierarchical regression analysis of maladaptive cognition symptoms, with demographic and negative interpretation bias predictors

Table S17

Summary of hierarchical regression analysis of maladaptive cognition symptoms (cPTCI) with gender, age, school index, baseline maladaptive cognition symptoms (T1), negative interpretation bias as predictor variables.

Predictors	B	S.E.*B*	*β*	ΔR^2	Adjusted R^2	Multiple *R*	Overall *F*
Step 1				.363	.346	.363	$F(4,146)=20.80$***
Gender	-.069	1.772	-.003				
Age	.014	.518	.002				
School index	-2.135	.993	-.153*				
Cognition (T1)	.573	.072	.544***				
Step 2				.004	.345	.367	$F(5,145)=16.80$***
Gender	.221	1.800	.008				
Age	.003	.519	.000				
School index	-2.173	.994	-.155*				
Cognition (T1)	.554	.075	.525***				
Negative interpretation bias	.887	.943	.066				

Note. cPTCI = child Posttraumatic Cognitions Inventory

*$p < .05$. ***$p < .001$

Appendix Q

Study 1 Hierarchical regression analysis of anxiety symptoms with demographic and negative interpretation bias predictors**.**

Table S18

Summary of hierarchical regression analysis of anxiety symptoms (BAI-Y) with gender, age, school index, baseline anxiety symptoms (T1), negative interpretation bias as predictor variables.

Predictors	B	S.E.*B*	β	ΔR^2	Adjusted R^2	Multiple R	Overall F
Step 1				.388	.371	.388	$F(4,146) = 23.10$***
Gender	.947	1.405	.044				
Age	-.008	.410	-.001				
School index	-1.753	.761	-.156*				
Anxiety (T1)	.526	.060	.580***				
Step 2				.001	.368	.389	$F(5,145) = 18.44$***
Gender	.819	1.430	.038				
Age	-.008	.411	-.001				
School index	-1.756	.763	-.156*				
Anxiety (T1)	.534	.062	.588***				
Negative interpretation bias	-.377	.738	-.035				

Note. BAI = Beck Anxiety Inventory – Youth

*p < .05. ***p < .001

Appendix R

Study 1 Hierarchical regression analysis of depression symptoms with demographic and negative interpretation bias as predictors

Table S19

Study 1 Summary of hierarchical regression analysis of depression symptoms (CDI-S) with gender, age, school index, baseline depression symptoms (T1), negative interpretation bias as predictor variables.

Predictors	B	S.E.*B*	*β*	ΔR^2	Adjusted R^2	Multiple *R*	Overall *F*
Step 1				.526	.513	.526	$F(4,145)=40.18$***
Gender	.712	1.137	.036				
Age	-.159	.331	-.028				
School index	-1.028	.622	-.100				
Depression (T1)	.637	.053	.699***				
Step 2				.010	.519	.535	$F(5,144)=33.20$***
Gender	.399	1.150	.017				
Age	-.152	.329	-.027				
School index	-1.009	.617	-.098				
Depression (T1)	.666	.056	.730***				
Negative interpretation bias	-1.046	.600	-1.742				

Note. Children Depression Inventory – Short Form

***$p < .001$

Appendix S

Study 1 Hierarchical regression analysis of outcome symptoms, with demographic, baseline symptoms and Ambiguous Situation Test as predictor variables.

Table S20

Summary of hierarchical regression analysis of trauma (CPSS), maladaptive cognition (cPTCI), anxiety (BAI-Y) and depression (CDI-S) symptoms with gender, age, school index, baseline symptoms (T1), Ambiguous Situation Test (AST) -negative interpretation bias as predictor variables

		Model 1		Model 2 (baseline symptoms controlled)	
Outcome Variables	Predictors	ΔR^2	F_{change}	ΔR^2	F_{change}
Trauma (CPSS)	Step 1				
	Control Variables[a]	.034	$F(3,152) = 1.55$	.251	$F(4,149) = 12.49$***[b]
	Step 2				
	AST-Negative interpretive bias	.004	$F(1,151) = 0.44$	.009	$F(1,148) = 1.81$
Cognition (cPTCI)	Step 1				
	Control Variables[a]	.089	$F(3,151)= 4.94$**[c]	.363	$F(4,146) = 20.80$***[d]
	Step 2				
	AST-Negative interpretive bias	.011	$F(1,150) = 1.83$	.005	$F(1,145) = 0.946$
Anxiety (BAI-Y)	Step 1				
	Control Variables[a]	.063	$F(3,151) = 3.36$*[e]	.387	$F(4,146) = 23.06$***[g]
	Step 2				
	AST-Negative interpretive bias	.028	$F(1,150) = 4.70$*[f]	.003	$F(1,145) = 0.603$
Depression (CDI-S)	Step 1				
	Control Variables[a]	.060	$F(3,150) = 3.20$*[h]	.526	$F(4,145) = 40.18$***[i]
	Step 2				
	AST-Negative interpretive bias	.013	$F(1,149) = 2.02$	.004	$F(1,144) = 1.086$

Note. CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory-Youth; CDI-S = Children's Depression

Inventory – Short Form [a] Control variables: Gender, Age, and School Index. [b-k] details significant variables within each step as follows: [b] T1 trauma symptoms, B = .490, SE = .075, p = .000; [c] School index, B = -4.193, SE = 1.127, p = .000; [d] T1 cognition symptoms, B = .573, SE = .072, p = .000, School Index, B = -2.135, SE = .993, p = .033; [e] School Index, B = -2.476, SE = .921, p = .008; [f] AST- negative interpretation bias, B = 1.916, SE = .884, p = .032, School index, B = -2.292, SE = .914, p = .013; [g]T1 anxiety symptoms. B = .524, SE = .060, p = .000, School index, B = -1.746, SE = .762, p =.023; [h] School Index, B = -2.324, SE = .847, p = .007; [i] T1 depression symptoms, B = .637, SE = .053, p = .000.

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

Appendix T

Study 2 Linear mixed modelling with outcome measures and moderators

Table S21. Linear mixed modelling significance values for the whole sample and clinical subset. Type 3 fixed effects of time, group and interactions (including moderators) on trauma and maladaptive cognition outcome measures.

	Whole Sample				Clinical subset		
	T1 –T4	T1 –T4†	T1 –T3		T1 –T4	T1 –T4†	T1 –T3
CPSS	N=125	N=113	N=125		n=38	n=36	n=38
Cond	.374	.217	.479		.564	.631	.509
Time	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**
Cond*Time	.904	.954	.797		.891	.942	.760
Cond*Time *Sex	.770	.787	.838		.788	.863	.567
Cond*Time *Age	.983	.951	.951		.952	.827	.774
cPTCI	N=368	N=333	N=368		n=135	n=123	n=135
Cond	.080	.137	.187		.519	.522	.865
Time	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**
Cond*Time	.062	.050	.085		.163	.192	.190
Cond*Time*Sex	.359	.315	.240		.727	.742	.559
Cond*Time*Age	.297	.524	.174		.545	.590	.406

Note. CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory. T1= time 1 (Baseline); T3= time 3 (3-month follow-up); T4 = time 4 (6-month follow-up). †T1-T4 = excludes one school that did not complete T4 assessment. **Bold values** = p < .05.

Table S22. Linear mixed modelling significance values for the whole sample and clinical subset. Type 3 fixed effects of time, group and interactions (including moderators) on anxiety and depression outcome measures

	Whole Sample						**Clinical subset**			
	T1 –T4	T1 –T4 †	T1 –T3		T1 –T4	T1 –T4	T1 –T4 †	T1 –T4 †	T1 –T3	T1 –T3
					TS =60	TS= 70	TS=60	TS=70	TS=60	TS=70
BAI-Y	N=368	N=333	N=368		n=93	n=44	n = 83	n=42	n =93	n=44
Cond	.734	.637	.807		.718	.825	.979	.976	.737	.580
Time	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**	**.000**	**.000**	**.000**
Cond*Time	.081	.272	**.045**		**.041**	.453	.068	.645	.132	.295
Cond*Time*Sex	.431	.460	.396		.957	.954	.991	.961	.826	.949
Cond*Time*Age	**.050**	**.044**	.163		.183	.219	.265	.281	.105	.288
CDI-S	N=367	N=322	N=367		n=62	n=27	n=54	n=25	n =62	n=27
Cond	.104	.178	.172		.787	.512	.909	.308	.865	.611
Time	.301	.269	.585		**.001**	**.001**	**.002**	**.002**	**.028**	**.006**
Cond*Time	.864	.826	.884		.625	.933	.557	.812	.434	.817
Cond*Time*Sex	.704	.619	.591		.971	.305	1.000	.173	.921	.340
Cond*Time*Age	.322	.224	.182		.340	.906	.381	.937	.368	.760

Note. BAI-Y = Beck Anxiety Inventory-Youth; CDI-S = Child Depression Inventory- Short Form; TS 60/70 = T-Score cut-off moderate to severe T1= time 1 (Baseline); T3 = time 3 (3-month follow-up); T4 = time 4 (6-month follow-up). †T1-T4 = excludes one school that did not complete T4 assessment. **Bold values** = p <.05

Table S23. Linear mixed modelling significance values for the whole sample and clinical subset. Type 3 fixed effects of time, group and interactions (including moderators) on the Test of Interpretive Bias negative and positive scale.

	Whole Sample				**Clinical subset**		
	T1 –T4	T1 –T4 †	T1 –T3		T1 –T4	T1 –T4 †	T1 –T3
TIBneg	N=369	N=334	N=369		N=81	n =71	n =81
Cond	**.005**	**.003**	**.007**		**.021**	**.010**	**.014**
Time	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**
Cond*Time	.203	.216	.121		.063	**.029**	**.029**
Cond*Time*Sex	.603	.644	.441		.330	.300	.218
Cond*Time*Age	.647	.607	.580		.132	.082	.104
TIBpos	N=369	N=334	N=369		n=90	n =79	n=90
Cond	.112	.179	.111		.361	.504	.301
Time	**.008**	**.021**	**.011**		**.000**	**.000**	**.000**
Cond*Time	.574	.561	.457		.587	.729	.500
Cond*Time*Sex	.866	.983	.684		.327	.226	.300
Cond*Time*Age	.643	.715	.791		.216	.314	.424

Note. TIB neg/pos = Test of Interpretive Bias – negative and positive scale; Negative clinical ≥75th percentile; Positive clinical ≤ 25th percentile;

T1= time 1 (Baseline); T3 = time 3 (3-month follow-up); T4 = time 4, (6-month follow-up). †T1-T4 = excludes one school that did not complete T4 assessment.

Bold values = p <.05

Table S24. Linear mixed modelling significance values for the whole sample and clinical subset. Type 3 fixed effects of time, group and interactions (including moderators) on the Ambiguous Situations Test negative and positive scale.

	Whole Sample				**Clinical subset**		
	T1 –T4	T1 –T4 †	T1 –T3		T1 –T4	T1 –T4 †	T1 –T3
ASTneg	N=369	N=334	N=369		n=85	n =71	n=85
Cond	**.003**	**.003**	**.006**		.114	n =73	.059
Time	**.038**	.059	**.017**		**.000**	.112	**.000**
Cond*Time	**.043**	.091	**.020**		.176	**.000**	.080
Cond*Time*Sex	.207	.128	.118		**.047**	.347	**.028**
Cond*Time*Age	.764	.808	.496		.923	**.036**	.924
ASTpos	N=369	N=334	N=369		n= 90	n=84	n=90
Cond	**.040**	.101	**.049**		.115	.158	.094
Time	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**
Cond*Time	.069	.089	**.028**		.193	.174	.110
Cond*Time*Sex	.231	.330	.160		.889	.926	.814
Cond*Time*Age	.420	.404	.508		.760	.796	.643

Note. AST neg/pos = Ambiguous Situations Test; Negative clinical ≥75th percentile; Positive clinical ≤ 25th percentile T1= time 1 (Baseline);

T3 = time 3 (3-month follow-up); T4 = time 4 (6-month follow-up). †T1-T4 = excludes one school that did not complete T4 assessment. **Bold values** = *p* <.05

Appendix U

Study 2 Demographic characteristics for study sample and descriptive statistics for study outcome measures

Table S25 Demographic Characteristics for study sample and descriptive statistics for study outcome measures

Variable	Sample 1 (N=188) *M* (*SD*)	Sample 2 (N=395) *M* (*SD*)	Total (N=583) *M* (*SD*)
Age Range in years	11.16 (1.76) 7-15	10.93 (.935) 9 -13	11.01 (1.21) 7-15
Male sex	50% (*n* = 94)	47% (*n* =187)	48% (*n* = 281)
Ethnicity			
White	93% (*n* =175)	92% (*n* = 364)	92.5% (*n* = 539)
Other	6% (*n* =12)	7 % (*n* = 29)	7% (*n* = 41)
Missing	1% (*n* = 1)	.5% (*n* = 2)	.5% (*n* =3)
School			
Primary	75.5% (*n* = 142)	100% (*n* = 395)	92% (*n* = 537)
Secondary	24.5% (*n* = 46)		8% (*n* = 46)
School region			
Metropolitan	55% (*n* = 103)	45% (*n* = 179)	48% (*n* = 282)
Regional	45% (*n* = 85)	55% (*n* = 216)	52% (n = 301)
School type			
Public	78% (*n* = 147)	55% (*n* = 218)	63% (*n* = 365)
Private	22 % (*n* = 41)	45% (*n* = 177)	37% (*n* = 218)
School Index Range	923-1075 (n = 6)	893-1136 (n = 6)	893-1136 (n = 12)
Measures / Score range	*M* (*SD*) [min-max]	*M* (*SD*) [min-max]	*M* (*SD*) [min-max]
CPSS (0-63)	17.28 (11.02) [0-57]	19.24 (12.86) [0-63]	18.60 (12.31) [0-63]
cPTCI (25-100)	39.87 (12.86) [25-84]	45.34 (15.83) [25-100]	43.57 915.14) [25-100]
BAI-Y *(25-100)	48.83 (11.88) [31-85]	52.25 (14.47) [27-100]	51.15(13.77) [27-100]
CDI-S *(25-100)	49.89 (11.13) [39-97]	51.47 912.28) [35-99]	50.88(11.82) [35-99]
AST 8 item (8-40)			
Negative scale	19.88 (5.29) [13-38]		
Positive scale	26.93 (4.88) [9-38]		
AST 16 item (16-80)			
Negative scale		41.29 (11.35) [16-76]	
Positive scale		55.67 (8.72) [16-80]	
TIB-12 item (0-12) Dichotomous negative	2.65 (1.49) [0-6]		
TIB-12 item (0-12) Dichotomous positive	9.36 (1.50) [6-12]		

TIB 12 item (0-24) Likert negative	15.35 (5.56) [8-29]	
TIB 12 item (0-24) Likert positive	23.12 (4.38) [16-31]	
TIB 24 item (0-72) Likert negative		29.34 (10.71) [9-65]
TIB 24 item (0-72) Likert positive		47.84 (8.21) [10-66]

Note: School Index with a *M* of 1000 and *SD* 100 (higher scores reflect higher advantage); TIB-Test of Interpretive Bias (negative and positive scale); AST- Ambiguous Situations Test (positive and negative scale); CPSS: Child Posttraumatic Symptom Scale; cPTCI: child Posttraumatic Cognition Inventory; BAI-Y: Beck Anxiety Inventory for youth; CDI-S: Child Depression Inventory-Short Form; *T-scores reported.

Appendix V

Study 1 Correlations between negative interpretation bias and outcome measures at 12 weeks follow up.

Table S26 Bivariate correlations between the Test of Interpretation Bias negative scale and outcome measures at 12 weeks follow up for participants with low symptom levels at baseline.

Outcome variable	n	TIB negative scale
Trauma (CPSS)	120	.28**
Cognition (cPTCI)	122	.18*
Anxiety (BAI-Y)	127	.02
Depression (CDI-S)	128	.00

Note: TIB = Test of Interpretive Bias; CPSS= Child Posttraumatic Symptom Scale; cPTCI= child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory- Youth; CDI-S = Child Depression Inventory-Short Form.

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

Appendix W

Study 3 CBM-I training scenarios examples

Table S27 CBM-I training scenarios examples

	Example of CBM-I training tasks ; Positive and Neutral conditions						
Domain of Threat	**Scenario**	**Positive**	**Neutral**	**Comprehension Question**	**Positive Yes response**	**Positive No response**	**Neutral Response**
Nothing good happens	You are looking forward to receiving your lunch order. You discover the order is not what you expected. You think lunch is going to be ……………………today	B-tter (Better)	N-w (New)	Was you lunch order better than expected? Yes/ No Did you get a new lunch? Yes/No	Correct answer ☺ Thinking how an unexpected situation can turn out well is smart.	Okay, but even if something went wrong remember sometimes a mistake can change things for the better.	You are correct You are incorrect
I can't cope when things get tough	Your teacher is handing back the test papers. Some of the papers appear to have lots of comments on them and others do not. When you received your paper you have lots of ……………....comments	N-ce (Nice)	Wr-tten (Written)	Did you get lots of nice comments? Yes/No Did you get lots of written comments on your paper? Yes/No	Correct answer ☺ Receiving nice comments on a test paper is a good feeling.	Okay, that can happen but remember teachers' comments are usually helpful. Can you remember when a teacher gave you some nice feedback on your work?	You are correct You are incorrect
I am no good	Your teacher asks you to write your answer on the white board for everyone to see. His reactions suggest you did …………….. *as ……………..	W-ll (Well)	*Exp-cted (Expected)	Did you do well with your answer? Yes /No Did you do as expected with your answer? Yes /No	Correct answer ☺ Doing something well, then sharing it with others is good for everyone.	Okay, sorry you didn't notice this. But remember you did have a go and we can't tell what others are thinking or feeling unless we ask them.	You are correct You are incorrect
Not getting over my fears means I've failed	You are practicing some skateboard moves. You are trying to do something new for the first time. You feel ………of your efforts.	Pr-ud (Proud)	Ok-y (Okay)	Are you proud of your efforts? Yes / No Are you okay with your efforts? Yes / No	Correct answer ☺ Being proud of your efforts helps to build your confidence.	Okay, but remember everyone (you) has the right to be proud of having a go at something new.	You are correct You are incorrect

I can't stop bad thing happening to me	You have entered a drawing competition and feel confident because you are good at Art. The winner gets their drawing put in the local newspaper. All the artwork is displayed upon the notice board for everyone to see but you can't find yours. It is obvious your drawing has been………..	Ch-sen (Chosen)	C-vered (Covered)	Was your artwork chosen for the newspaper? Yes/no Was your artwork covered? Yes/no	Correct answer ☺ Thinking about a good result makes sense when you are waiting on more information.	Okay but even if your work was not chosen, remember you need the facts to be sure about what has happened.	You are correct You are incorrect
Everyone lets me down	You spend some time helping students with their schoolwork. Later you hear them talking about you. What you hear them say is ………………	Appr-ciated? (Appreciated)	Tr-e (True)	Did the others appreciate your help? Yes /No Were the students' comments true? Yes/No	Correct answer ☺ Peoples' private chat about another person can often be very positive.	Okay it may not be helpful to be hard on yourself but remember you did use your ability to help others.	You are correct You are incorrect
Anyone can hurt me	You are watching some students who are standing near an upset child. *It is clear the students are ……………..to this person.	N-ce (Nice)	T-lking (Talking)	Are the students being nice to the upset child Yes/No? Are the students talking to the upset child? Yes/No	Correct answer ☺ People can be nice when someone is upset.	Okay, but remember, most people respond in a nice way when others are upset?	You are correct You are incorrect
I don't fit in	You got a new hair cut over the weekend and you are adjusting to your new look. As you walk into the classroom it is clear by the students' reactions, they………it.	L-ke (Like)	S-e (See)	Do the students like your new hair cut? Yes / No Did the students see your new hair cut? Yes / No	Correct Answer ☺ Noticing what others like about you builds good self-esteem.	Okay, it is normal for people to like different things but remember you have the right to like different things too.	You are correct You are incorrect
Small things upset me Something is wrong with me	As you enter the stage you see people in the audience ……………………….at you	Sm-ling (Smiling)	L-oking (Looking)	Did people from the audience smile at you? Yes /No Did people from the audience look at you? Yes/No	Correct answer ☺ You are able to notice how others enjoy what you do.	Okay, but remember sometimes people like something but don't always show it.	You are correct You are incorrect
I have to watch out for danger	You hear some loud noises coming from the room next door. You realise the sound is people …………….….	C-lebrating (Celebrating)	M-ving (Moving)	Were the loud noises coming from people celebrating? Yes/No	Correct answer ☺ You've worked out that people having fun can be noisy at times.	Okay It is not always easy to make sense of a situation, but remember it helps to get more	You are correct You are incorrect

				Were the loud noises coming from people moving? Yes /No		information about what is happening before making up your mind.	
I don't trust people I have to be really careful	You are walking with the dog when you notice a car pulling up to the kerb. As you look closer you realise the person driving is …………………	F-miliar (Familiar)	P-rking (Parking)	Did you know the person driving up to the kerb? Yes / No Was the person driving up to the kerb parking? Yes/No	Correct answer ☺ It is helpful to give yourself plenty of time to think about a situation.	Okay, but remember sometimes it can be helpful to give yourself extra time to think about a situation before you react.	You are correct You are incorrect
I'm no good	You have to give a speech to the class. As you wait outside for your turn, you hear the class' response after another student's talk. This means it was ……	L-ked (Liked)	Ov-r (Over)	Did the students like the talk? Yes/No Was the talk over? Yes/No	Correct answer ☺ Thinking how well the class liked a talk is helpful because it reminds you of how others can appreciate your talk too.	Okay, giving a talk to the class can be hard but it helps to think about all the things that can go well in these situations.	You are correct You are incorrect

Appendix X

Study 1 Re-analyses of outcome measures comparing samples using the Test of Interpretation Bias Dichotomous and Likert type response formats

Table S28 Proportion of at risk (high negative bias) children moving to clinical range at 12 weeks follow up on outcome measures of trauma, maladaptive cognition, anxiety and depression for Study one's two samples.

		Sample 1 (n=150)		Sample 2 (n=38)	
		Status at 12 weeks follow up		Status at 12 weeks follow up	
Variable	Risk status at baseline	Normal range (n, %)	Clinical range (n, %)	Normal range (n, %)	Clinical range (n, %)
Trauma (CPSS)	Low bias / low symptoms	27 (93.1)	2 (6.9)	8 (88.9)	1 (11.1)
	High bias / low symptoms	17 (73.9)	6 (26.1)	7 (100)	0 (0)
Cognition (cPTCI)	Low bias / low symptoms	29 (93.5)	2 (6.5)	6 (85.7)	1 (14.3)
	High bias / low symptoms	20 (80)	5 (20)	7 (100)	0 (0)
Anxiety (BAI-Y)	Low bias / low symptoms	31 (100)	0 (0)	6 (85.7)	1 (14.3)
	High bias / low symptoms	24 (96)	1 (4)	8 (72.7)	3 (27.3)
Depression (CDI-S)	Low bias / low symptoms	30 (100)	0 (0)	6 (85.7)	1 (14.3)
	High bias / low symptoms	22 (95.7)	1 (4.3)	8 (88.9)	1 (11.1)

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y = Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form; Sample 1= participants used the Test of Interpretative Bias -Dichotomous response format; Sample 2 = participants used the Test of Interpretative Bias -Likert response format.

Table S29 Summary of hierarchical regression analysis for the two study samples, predicting of trauma, maladaptive cognition, anxiety and depression symptoms: Gender, age, school index, baseline symptoms, negative interpretation bias as predictor variables.

		Sample 1 (n=140)				Sample 2 (n=38)			
		Model 1		Model 2 (baseline symptoms controlled)		Model 1		Model 2 (baseline symptoms controlled)	
Outcome Variables	Predictors	ΔR^2	F_{change}	ΔR^2	F_{change}	ΔR^2	F_{change}	ΔR^2	F_{change}
Trauma (CPSS)	Step 1 Control Variables[a]	.044	*F*(3,119) =1.83	.19	*F*(4,118) = 6.70***[c]	.065	*F*(2,29) = 2.07	.545	*F*(3,27) =10.77***[e]
	Step 2 Negative bias	.07	*F*(1,118) =8.87***[b]	.04	*F*(1,117) = 5.48*[d]	.130	*F*(1,28) = 3.16	.021	*F*(1,26) = 1.23
Cognition (cPTCI)	Step 1 Control Variables[a]	.12	*F*(3,117) = 5.26**[f]	.26	*F*(4,116) = 10.34***[g]	.191	*F*(2,30) = 3.55*[h]	.763	*F*(3,26) =27.86***[j]
	Step 2 Negative bias	.01	*F*(1,116) = 1.38	.002	*F*(1,115) = 0.35	.16	*F*(1,29) = 7.03*I	.021	*F*(1,25) =2.42
Anxiety (BAI-Y)	Step 1 Control Variables[a]	.07	*F*(3,117) = 2.73*[k]	.33	*F*(4, 116) = 13.99***[l]	.23	*F*(2,30) = 4.36*[m]	.58	*F*(3,26) =11.76***[n]
	Step 2 Negative bias	.000	*F*(1,116) = 0.06	.003	*F*(1,115) = 0.53	.05	*F*(1,29) =1.79	.004	*F*(1,25) = 0.23
Depression (CDI-S)	Step 1 Control Variables[a]	.07	*F*(3,116) = 2.87*[o]	.505	*F*(4,115) = 29.29***[p]	.09	*F*(2.30) = 1.62	.58	*F*(3,26) = 12.16***[q]
	Step 2 Negative bias	.003	*F*(1,115) = 0.31	.010	*F*(1,114) = 3.03	.05	*F*(1,29) = 1.59	.02	*F*(1,25) = 1.16

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y= Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form. [a] Control variables: Gender, Age, and School Index. [b-q] details significant variables within each step as follows: [b] Negative interpretation bias, B = 2.739, SE = .919, p =.004, School Index, B = -1.976, SE = .889, p = ..028; [c] T1 trauma symptoms, B = .389, SE = .086, $p < .001$; [d] Negative interpretation bias, B = 2.059, SE = .880, $p = .021$, T1 trauma symptoms, B = .350, SE = .086, $p < .001$; [e] T1 trauma symptoms, B = .757, SE = .152, $p < .001$; [f] School index, B = -4.142, SE = 1.065, $p < .001$; [g] T1 cognition symptoms, B = .413, SE = .088, $p < .001$, School index, B = -2.664, SE = .1.0, $p = .01$; [h] Gender, B = 13.58, SE = 5.504, $p = .02$; [i;] Negative interpretation bias, B = 6.43, SE = 2.43, $p = .013$; [j] T1 cognition symptoms, B = .843, SE = ..107, $p < .001$; [k] School index, B = -2.391, SE = .856, $p = .006$; [l] T1 anxiety symptoms, B = .450, SE = .067, $p < .001$, School index, B = -1.833, SE = .735, $p = .014$; [m] Gender, B = 13.64, SE = 4.63, $p = .006$; [n] T1 anxiety symptoms, B = .648, SE = .140, $p < .001$; [o] School index, B = -2.330, SE = .814. $p = .005$; [p] T1 depression symptoms, B = .624, SE = .062, $p < .001$; [q] T1 depression symptoms, B = .644, SE = 0.117, $p < .001$;

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

Table S30 Logistic regression of trauma, maladaptive cognition, anxiety and depression outcome measures as a function of gender, age school index and negative interpretation bias variables for Study one's 2 samples.

Trauma (CPSS)														
	Sample 1 (n = 142)							Sample 2 (n = 36)[a]						
						95% CI for OR							95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.08	0.42	0.04	.84	1.09	0.48	2.47	0.92	1.24	0.55	.46	2.51	0.22	28.7
Age in years	-0.13	0.14	0.80	.37	0.88	0.67	1.16	1.97	1.21	2.65	.10	7.20	0.67	77.6
School Index	-0.33	0.20	2.65	.10	0.72	0.49	1.07							
Negative bias	0.23	0.21	1.24	.27	1.26	0.84	1.88	3.22	1.43	5.05	.02	25.0	1.51	416.6
Constant	0.25	1.51	0.30	.87	1.29			-29.59	16.98	3.03	.08	0.00		
Maladaptive Cognition (cPTCI)														
	Sample 1 (n=141)							Sample 2 (n = 34)[a]						
						95% CI for OR							95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.59	0.48	1.50	.22	1.81	0.70	4.65	1.40	1.10	1.60	.20	4.07	0.46	35.8
Age in years	-0.17	0.16	1.21	.27	0.84	0.62	1.15	1.30	0.92	1.99	.16	3.66	0.60	22.2
School Index	-0.57	0.23	6.15	.01	0.56	0.35	0.87							
Negative bias	0.35	0.23	2.31	.128	1.42	0.90	2.24	2.15	0.89	5.85	.02	8.59	1.50	49.1
Constant	0.91	1.67	0.01	.91	1.21			-19.8	12.8	2.41	.12	0.00		
Anxiety (BAI-Y)														
	Sample 1 (n=141)							Sample 2 (n = 34)[a]						
						95% CI for OR							95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.24	0.47	0.26	.61	1.27	0.50	3.21	4.02	1.64	6.05	.01	55.9	2.26	1382.5
Age in years	0.18	0.16	1.18	.28	1.19	0.87	1.63	0.47	1.17	0.16	.69	1.59	0.16	15.76
School Index	-0.18	0.22	0.65	.42	0.84	0.54	1.29							
Negative bias	0.26	0.23	1.28	.26	1.29	0.83	2.03	1.83	0.82	4.96	.03	6.22	1.24	31.07
Constant	-3.52	1.77	3.95	.05	.03			-10.34	16.18	0.41	.52	0.00		
Depression (CDI-S)														
	Sample 1 (n=141)							Sample 2 (n = 34)[a]						
						95% CI for OR							95% CI for OR	
Variables	*B*	S.E.	Wald's test	*p*	OR	LL	UL	*B*	S.E.	Wald's test	*p*	OR	LL	UL
Gender	0.80	0.54	2.22	.14	2.22	0.78	6.32	2.39	1.24	3.76	.05	10.99	0.97	124.1
Age in years	-0.11	0.17	0.39	.53	0.89	0.64	1.26	1.21	0.92	1.74	.19	3.37	0.55	20.45
School Index	-0.51	0.25	4.15	.04	0.60	0.36	0.98							
Negative bias	0.49	0.25	3.66	.06	1.62	0.98	2.67	0.92	0.52	3.12	.08	2.51	0.90	6.98
Constant	-0.96	1.82	0.28	.59	0.38			-19.23	12.98	2.19	.14	0.00		

Note: CPSS = Child Posttraumatic Symptom Scale; cPTCI = Child Posttraumatic Cognition Inventory; BAI-Y= Beck Anxiety Inventory for youth; CDI-S = Children's Depression Inventory – Short Form; OR= Odds ratio; CI = confidence interval; LL= lower limit; UL=upper limit.