Review Article • DOI: 10.2478/s13380-013-0110-9 • Translational Neuroscience • 4(1) • 2013 • 88-95

VERSITA

Translational Neuroscience

COGNITIVE FINDINGS IN CHILDHOOD ANXIETY: TRANSLATIONS FOR CLINICAL PRACTICE

Katharina Manassis*

University of Toronto, Department of Psychiatry, Hospital for Sick Children, 555 University Avenue, Toronto, Ontario, M5G 1X8, Canada

Abstract

Background: The study of cognition in anxious children (i.e., those with anxiety disorders and those with high trait anxiety) is a burgeoning field. Cognitive biases towards encoding threatening information, interpreting stimuli as threatening, and selecting avoidant responses have been found to affect these children, and in some cases their parents too. These biases as well as certain cognitive abilities and deficits have been related to childhood anxiety and its treatment. Given the plethora of recent findings, implications for the practicing clinician are not always obvious. *Methods*: Using a review of recent medical literature, this paper summarizes key findings and examines potential links to clinical practice. *Results*: The need to appreciate the reciprocal relationship between anxiety and cognition is highlighted (i.e., anxiety can contribute to cognitive biases and deficits, but cognitive problems can also contribute to anxiety). Cognitive factors can also predict poor response to traditional treatments, and thus suggest modifications of treatment that may benefit some children. Treatments focused on cognitive biases are gaining popularity, but their role in the treatment of anxious children and in relation to other anxiety treatments merits further study. *Conclusion:* Recent cognitive findings enhance our clinical understanding of anxious children, and may suggest ways of tailoring evidence-based treatments to best meet the needs of children with diverse cognitive profiles and developmental needs.

Keywords

• Cognition • Anxiety • Anxiety disorders • Children • Cognitive bias • Threat perception

Received 13 February 2013
accepted 16 February 2013

Introduction

In the past decade, the literature on cognition in anxious children has expanded rapidly. New findings, new paradigms, new measurement techniques, and even new treatments have been reported. Unfortunately, as in many clinical fields where a large quantity of new information exists, the implications for the practicing clinician are not always obvious. This paper attempts to elucidate these implications and some areas where clinical application of findings may be premature, in order to offer guidance regarding the translation of cognitive findings in childhood anxiety for clinical practice.

To ensure a thorough review of relevant findings, a search of PubMed was undertaken using the search words "cognition", "anxiety", and "children". As this search yielded several hundred papers, only those published within the past 10 years were retrieved. Key citations within these retrieved papers were also obtained, including some from the psychological literature. Thus, this paper represents a selective rather than exhaustive review with emphasis on recent findings. All information was then organized by the author in order to facilitate interpretation of literature and translation for clinical practice.

To begin, an overview of various aspects of cognition studied in anxious children is provided. Daleiden and Vasey [1] provided a model for aspects pertaining to cognitive biases using an information processing perspective. This model is summarized, and then the relevance of cognitive deficits is introduced. Next, common research paradigms are briefly described and compared. Recent findings are then classified according to how anxious children compare to unaffected controls and how cognition relates to treatment, and the clinical implications of each type of finding are presented and summarized in a table. Substantial literature has examined children with anxious tendencies (termed "high trait anxiety") as well as children with diagnosed anxiety disorders, so findings pertaining to both groups are included. Finally, important considerations in interpreting the findings are discussed and the effects of these considerations on clinical translation are examined.

Information processing and childhood anxiety

Clinicians have long recognized the tendency for individuals to become more anxious as they focus upon threatening situations and threatening stimuli in their environment. Drawing upon earlier work by Crick and Dodge [2] on information processing, Daleiden and Vasey [1] outlined a cognitive model for childhood anxiety, which relates to this tendency. In this model, children respond to information from their environment in six sequential stages: encoding information, interpreting information, using information for goal clarification or construction, response retrieval from memory or response construction, response selection, and enactment of the response. These stages are thought to lie on a spectrum from those involving little conscious

* *E-mail: katharina.manassis@sickkids.ca*

control (i.e., rapid, low effort, low intentionality) to those involving a high degree of conscious control (i.e., slow, high effort, high intentionality). In general, the earlier information processing stages are thought to involve less conscious control than the later stages.

When comparing anxious and non-anxious children on these various aspects of information processing, anxious children have typically been found to *encode* more threatening information (i.e., selectively attend to or be easily distracted by threatening information), *interpret* more information as being threatening and beyond their coping abilities, and *select* more avoidant responses [3]. Psychological interventions in this population have therefore focused on correcting threat-biased interpretations, encouraging and practicing responses that involve approach rather than avoidance of anxious situations and, most recently, correcting threat-biased attention. Cognitive behavioral therapy (CBT), which has the most substantial evidence base in childhood anxiety disorders [4], preferentially targets those aspects that involve a high degree of conscious control.

In addition, cognitive deficits are important to recognize and study in anxious children for several reasons. First, children spend a substantial amount of their time in school where cognitive performance is expected and evaluated. Cognitive difficulties are potentially anxiety-provoking in this setting. Children with dyslexia, for example, show high rates of anxious symptomatology [5]. Second, there is evidence that anxiety can influence academic performance. Longitudinally, Grover, Ginsburg, and Ialongo [6] found that children with high trait anxiety in the first grade of school scored lower on measures of academic achievement in eighth grade. Third, in order to benefit from CBT children require certain cognitive abilities, and children with deficits in these abilities (for example, those with executive function deficits) may respond less optimally to this treatment [7].

Common paradigms for studying cognition in anxious children

To accurately interpret findings about cognition in anxious children, it is important to review experimental paradigms commonly used in this type of research. Some studies focus exclusively on children, while others include cognitive measures of their parents as well. Some studies focus on one paradigm, while others include several. The latter approach raises the question of whether the order of administration of measures may affect results, as doing one task may influence responses on the next one. Many studies counterbalance the order of task administration to minimize such order effects. Consistent with the information processing model described earlier, the most common paradigms focus on attention bias, interpretation bias, and response bias. Further experimental measures focus on cognitive content and cognitive deficits.

Attention bias tasks

Attention bias tasks are reviewed in greater detail by Puliafico and Kendall [3]. The most commonly used paradigm in the recent literature is the dot-probe detection task (detailed in [8]). In this task, two words or pictures are presented on a computer screen for a brief time (generally less than 1500 ms). Subsequently, a dot is presented in the location of one of the stimuli and children are told to press a button to show the location of the dot (for example, right button if stimulus is on the right and left button if stimulus is on the left). Anxious children typically show shorter response times when the dot appears in the place where a threat-related stimulus previously appeared than when it appears in the place where a neutral stimulus previously appeared, indicating biased attention towards threat. Because the threatening stimulus disappears quickly, the chance of an ongoing emotional reaction affecting task performance is minimized. Numerous studies have found attention bias towards threatening words using this task, but findings are less consistent for threatening pictures [9].

A second task targeting attention bias is the emotional Stroop task. In this task, threat-related words and neutral words are printed in different colors, and the child is asked to identify the color of each word as quickly as possible. Responses for threat-related words are typically slower than for neutral words, as either the subject's attention to or emotional reaction to the threatening words interferes with task performance. This slowing effect is more pronounced in anxious than non-anxious children. This task has been criticized for its inability to distinguish attention effects from emotional effects [3], and so has been used less frequently than the dot-probe detection task in recent studies.

A smaller number of studies have examined memory bias, rather than attention bias. These have generally found preferential recall of threatening versus non-threatening stimuli in anxious children [10].

Interpretation Tasks

Interpretation tasks are described in greater detail in Alfano, Beidel, and Turner [11]. The most commonly used interpretation tasks involve ambiguous situations. Although there are many variations on this theme, ambiguous situation tasks generally provide a limited amount of information to a child about a specific situation that *could* involve threat, but could also be benign. The child is then asked to interpret the situation, and the researcher uses this interpretation to evaluate how threatening or non-threatening the child perceives the situation.

Tasks involving ambiguous pictures (rather than situations) have also been presented to anxious children. In one recent study, anxiety disorder-specific pictures were presented in an online, forced choice reaction time task [12]. Children with separation anxiety disorder rated ambiguous pictures pertaining to separation more unpleasant and arousing than nonanxious children did.

Other studies related to interpretation bias have included self-report questionnaires [13]. Questionnaires are, however, potentially affected by reading and other cognitive skills, and by reporting biases (for example, children's wish to provide socially desirable responses). Some studies of interpretation bias focused on specific types of anxiety. For example, studies of anxiety sensitivity evaluated children's tendency to interpret physical cues as threatening [14]. Finally, some authors

examined children's ability to apply reappraisal (i.e. re-interpretation) to regulate negative emotions after viewing threatening scenes [15]. These tasks clearly involved more conscious effort than those involving immediate responses to pictures or situations.

Goal and response tasks

In these tasks, children are presented with situations that are potentially threatening and asked to formulate a planned response. Avoidant responses are typically increased among anxious compared to non-anxious children (reviewed in [11]). In some cases, discussions with parents are included when children formulate their response plans, to determine parental effects on the children's responses. Such discussions often increase children's avoidant response tendencies [16].

Cognitive content measures

These measures typically involve self-reports of cognitive content, either generally or in relation to anxiety-specific tasks. Examples include reports of negative self-statements and states of mind [17], self-focused attention and negative review of past events in social anxiety [18-20], thought-listed worry episodes [21], and coping strategies [22]. Such reports obviously involve a high degree of conscious awareness, and, like all self-reports, are subject to social desirability and other reporting biases.

Cognitive deficit tasks

Cognitive deficits thought to be most relevant to child anxiety are those involving executive functions and language. Executive functions involve the frontal areas of the brain, and are crucial to the regulation of attention and emotion, including the regulation of anxiety. Executive functions develop and improve throughout childhood, but are sometimes impaired in children with various psychiatric disorders or learning disabilities. For example, children with attention deficit hyperactivity disorder (ADHD) as well as anxiety disorders typically do poorly on tasks requiring a high degree of working memory (the ability to concurrently hold information in memory and manipulate it) [23]. Language deficits have been linked to increased anxiety in longitudinal studies of children and youth [24]. Language and executive functions are also highly relevant to the treatment of anxiety, as the most common psychological treatment for anxiety, cognitive behavioral therapy, typically requires at least average linguistic and working memory ability [7].

Implications of comparisons of anxious and non-anxious children

Most studies of cognition in anxious children involve comparisons with non-anxious groups of children. The clinical implications of these studies differ depending on whether anxious children: a) show a difference relative to non-anxious children; or b) show a deficit or strength relative to non-anxious children. Findings pertaining to each of these possibilities will be reviewed, and then linked to potential clinical implications which are shown in Table 1. Caution is warranted when drawing clinical conclusions, however, and important considerations when interpreting the literature are discussed later in the paper.

Cognitive differences

Differences between anxious and non-anxious children have been found most consistently in the information processing paradigms described above. Attention to threat, interpretation of ambiguous stimuli as threatening, and a tendency to choose avoidant responses to potentially threatening situations are all more typical of anxious than non-anxious children [10, 11,13,25].

Recent studies have examined these differences in more detail for certain diagnostic groups. For example, self-focused attention is usually higher in social anxiety than other disorders, and mediates the relationship between social anxiety and state anxiety [18]. Socially anxious children also evaluate themselves poorly after performance situations, even when independent observers do not [19,20,26]. Children with separation anxiety responded more negatively to ambiguous separation pictures than non-anxious children [12]. Children with high anxiety sensitivity (tendency to interpret physical sensations catastrophically) showed attentional vigilance for emotional versus neutral words [27]. Specificity findings are not entirely consistent, however. For example, Roy, Vasa, Bruck, Mogg, Bradley, Sweeney, and colleagues [28] did not find disorder specificity in an attention bias task involving threatening faces.

Building upon the work of Barrett and colleagues [16] regarding parents of anxious children, Lester, Field, Oliver, and Cartwright-Hatton [29] found that anxious parents tend to have threat interpretation biases, including to situations involving their child. Such biases may offer one explanation of how conversations between anxious children and their parents may unintentionally foster avoidant responses in children.

Possible implications

The presence of cognitive biases involving interpretation of stimuli and choice of responses is informative to clinicians practicing CBT with anxious children. Addressing interpretation biases by training children in positive reappraisal strategies and overcoming avoidance through exposure are central elements of successful treatment. Moreover, overcoming avoidance through exposure can be practiced regardless of the child's cognitive abilities, particularly when children are motivated to do so. Thus, cognitive limitations do not preclude successful treatment when clinicians foster children's engagement in therapy and motivation to "face fears." The possible disorder specificity of some biases merits attention, particularly in children with social anxiety where consistently negative (and unrealistic) self-evaluation may need to be addressed.

Unfortunately, biased encoding of threatening information is a rapid process that is minimally amenable to conscious control, and thus unlikely to respond to CBT. Knowing this information may be useful when discussing treatment expectations with

Table 1. Translational implications for cognitive findings in anxious children.

Key cognitive finding	Possible implications
Threat-biased encoding of information; bias not always responsive to CBT	As encoding is a fast process with little conscious control, children and their parents should not necessarily expect the tendency to become anxious by perceiving threat to improve with CBT; rather the ability to cope with anxiety improves. Children who constantly perceive threat (making it difficult to challenge all of their worries) may benefit from cognitive retraining, mindfulness-based approaches, or anxiety-focused medication
Threat-biased interpretation of stimuli or situations	CBT addresses this, but specific biases may merit additional attention (e.g., interpretation of physical stimuli in those with high anxiety sensitivity; interpretation of personal performance in social anxiety)
Threat-biased responses (i.e.., avoidance of feared situations)	Overcoming avoidance plays a central role in CBT and merits behavioral intervention regardless of children's cognitive coping abilities
Weakness in positive reappraisal	Strengthening positive reappraisals may enhance treatment benefits
Cognitive deficits have been linked to worry	Children with developmental or learning disabilities are at high risk of anxiety. Do not assume that anxiety is the cause of learning problems: children with academic problems require cognitive evaluation, regardless of their anxiety level
Extreme anxiety impairs cognitive performance; mild anxiety may enhance it	Anxious children are disadvantaged by educational practices that raise their anxiety level further (e.g., unexpected quizzes)
Executive function deficits have been linked to anxiety, and are prominent in children with comorbid ADHD	Treatment for children with such deficits may need to be individualized and simplified (e.g., reducing working memory expectations in CBT). Interventions (medical and psychological) that target executive functions may facilitate anxiety-focused treatment
Language deficits have been linked to increased anxiety and also found in selective mutism	Detection and treatment of such deficits is important for improving these children's mental health. Anxiety-focused treatments may need to be individualized and simplified for these children (e.g., de-emphasizing reading and writing, simplifying vocabulary)
Parents of anxious children may share their cognitive biases and inadvertently reinforce avoidance	These parents may need to be trained to recognize their children's strengths, positively reinforce approach behavior, and assume their children can cope with feared situations
Developmentally, young children have low emotional understanding and executive function abilities, often focus on physical rather than social threats, and are dependent on families to aid emotion regulation	Intervention with young children may need to focus on developing emotional understanding, have low emphasis on executive function abilities, and constructively involve families. Intervention with adolescents may need to respect developing executive functions (e.g., focus on hypothesis-testing rather than reassuring statements), attend to social as well as physical threats, and involve families less in developing emotion regulation skills

families. Thus, parents should not necessarily expect their children to stop becoming anxious as a result of vigilance to threat following treatment, but rather to cope better with anxiety as it arises. Additional types of treatment may also merit consideration in children with prominent attentional biases to threat (see below).

Finally, the fact that parents of anxious children sometimes share their cognitive biases suggests that these parents may benefit from training to recognize their children's strengths (as they would naturally attend to their weaknesses), to positively reinforce approach behavior (as they would naturally reinforce avoidance, even if this is not intended), and to give their child the benefit of the doubt in potentially fearful situations (i.e., assume the child can cope, rather than assuming the child will not cope).

Deficits and strengths

When examining cognitive deficits in anxious children, it is important to appreciate the bidirectional relationship between cognition and anxiety. In other words, anxiety can interfere with some aspects of cognition, but cognitive deficits can also contribute to anxiety. Anxiety has been found to interfere with positive reappraisals that children need to cope with negative emotion [15,22]. High levels of anxiety can also impair overall cognitive performance, though mild levels of anxiety are motivating and can enhance cognitive performance [30]. When anxiety occurs in the context of other psychiatric disorders, further cognitive impairment can occur. For example, selective mutism, a condition typically related to social anxiety, has been linked to language deficits [31]. As mentioned earlier, anxiety that is comorbid with ADHD has been linked to working memory deficits [23].

Cognitive deficits may also, however, increase children's risk for anxiety symptoms. For example, a one standard deviation advantage in cognitive performance was associated with a significantly reduced risk of GAD in childhood and adolescence [32]. Developmental delays in problem solving were correlated with excessive worry in anxious children [21]. As mentioned, language impairment has also been associated with anxiety longitudinally [24].

Possible implications

Given these bidirectional effects between cognition and anxiety, clinicians cannot attribute cognitive problems in anxious children entirely to their anxiety unless a careful psychological assessment has been

done to rule out cognitive deficits. Children with language or learning disabilities are at increased risk of anxiety disorders, particularly when their disabilities are not diagnosed and addressed. Conversely, educational practices that unnecessarily increase anxiety (for example, unexpected quizzes or other stressful cognitive evaluations) may place children with high trait anxiety at a particular disadvantage relative to their peers (see [33]).

In the psychological treatment of children's anxiety (principally CBT), particular emphasis on developing positive reappraisals may be warranted. Children with anxiety and concurrent language or learning difficulties may require individualized, simplified treatment. For example, reducing the working memory requirements of treatment may be helpful for anxious children with deficits in this area. Decreased emphasis on reading and writing as well as simplified vocabulary may be helpful when treating anxious children with language-related deficits. Interventions which improve language or executive function abilities (for example, speech-language therapy, reading remediation, medical treatment of ADHD) may also enhance children's ability to benefit from CBT.

Cognition in relation to treatment of childhood anxiety

Few studies in children have examined the relationship between cognition and response to anxiety treatment. Those that have done so pertain to CBT, and have considered cognitive factors as potential moderators of treatment outcome, mediators of treatment outcome, or targets of treatment.

Moderators are factors that predict the degree of treatment-related improvement of symptoms. Cognitive biases on two variations of the dot probe task were found to predict poor response to standard CBT protocols [34,35]. Legerstee and colleagues then provided a highly intensive form of CBT to non-responders, with improved treatment response [34]. As the dot probe task measures anxious children's tendency to rapidly encode threatening information, it is possible that children with this tendency are overwhelmed with threatening stimuli and thus have few cognitive resources available to learn and apply new strategies when using standard CBT protocols. As mentioned, high levels of anxiety can be deleterious to cognitive function [30].

Mediators are factors thought to be integral to the process of therapeutic change (i.e., without the mediator, treatment-related change is substantially diminished). Although literature is scant, studies suggest that changes in anxiety-related cognitive content mediate change in successful CBT [17,36]. These findings are consistent with CBT's emphasis on effortful, intentional change of cognition, a process that is more likely to affect cognitive content than underlying attentional biases such as those measured by the dot probe task. Interestingly, anxiety symptoms have been found to improve in some children with interventions that did not target cognitive content directly [37], indicating that further studies of mechanisms of therapeutic change in anxious children may be needed.

Studies of the effects of treatment on cognition have yielded variable results. Cresswell, Schniering, and Rapee [38] found that anxious children's threat interpretation biases decreased with CBT, as did those of their mothers. Manassis and colleagues [35], however, found no treatment-related changes in a probe position task from pre- to post-CBT in anxious children. One study that may reconcile these findings examined attentional bias on a visual probe task, threat interpretation bias, and selection of avoidant solutions in the same children before and after CBT. Children's interpretation bias and the selection of avoidant solutions changed in the expected direction, but attentional bias did not [39]. Once again, these findings suggest that CBT is most influential on aspects of information processing involving a high degree of conscious control (i.e., slow, high effort, high intentionality).

Given the accumulating evidence suggesting that attentional bias is relatively refractory to CBT, treatments targeting this bias have emerged. In the adult literature, there are numerous trials attesting to the efficacy of attention bias modification treatment (ABMT) for ameliorating anxiety symptoms [40], though a meta-analysis found only modest effect sizes [41]. Recent studies in children have demonstrated that, compared to placebo attention training, training designed to shift attention away from threat reduces anxiety symptoms and disorder severity [42-44]. Waters, Pittaway, Mogg, Bradley, and Pine [45] also reported that ABMT towards positive faces reduced anxiety symptoms and number of diagnoses. Given the relative novelty of this treatment, however, it awaits further evaluation comparing it with other evidence-based treatments and determining whether or not there are potential adverse effects. For example, is it detrimental in some children to reduce their capacity for attention to threat (e.g. those living in threatening circumstances)? It is also unclear how long the benefits of ABMT last and how to best integrate ABMT in the multimodal treatment of complex cases. The availability of ABMT is currently limited largely to research centres.

Possible implications

Highly intensive CBT may ameliorate attentional biases towards threat, but augmenting CBT with other treatments (i.e., either medication or ABMT if available) could also be considered in affected children. ABMT awaits further evaluation to determine its optimal role in relation to other evidence-based treatments. Mindfulness-based approaches in CBT, which train individuals to observe (rather than challenge) negative cognitive content may also be helpful, although they may be challenging for pre-adolescent children with limited meta-cognition (the ability to "think about one's thinking"). Interpretation and response biases are likely to respond to traditional CBT. Cognitive deficits have received little research attention as potential moderators of treatment outcome, but the presence of such deficits often challenges therapists to adapt CBT materials appropriately [7].

Considerations when interpreting the literature

Developmental effects

No review of cognition in anxious children is complete without acknowledging the limitations of what is known, and some

considerations when interpreting the literature. Perhaps the most crucial consideration is the need to better understand developmental effects on the constructs and the findings reviewed. Cognitive development can affect all aspects of information processing. Children's reading ability, language skills, and vocabulary for feelings can all affect questionnaire results. Reading comprehension can affect their interpretation of ambiguous scenarios. The emotional understanding of young anxious children can also be limited [11, 46], potentially affecting their reports on research measures. In particular, young children often under-report anxious symptoms [47], or have a poor grasp of the link between cognition and emotion [48]. Children may also have greater difficulty than adults consciously re-allocating attention [49] and addressing biases using effortful control [3] as their executive functions are not yet fully developed. These difficulties may influence research results and limit generalizability of adult findings to children.

Specific fears and biases may also be affected by development. For example, as abstract reasoning increases with adolescence, self-consciousness and social anxiety can increase in all children, whether or not they are clinically anxious [50,51]. Conversely, fears of physical danger and punishment decrease with age in community samples [51]. The ability to perceive physical symptoms as a signal of anxiety is also age-related [52]. Each of these developmental changes can affect research results, as the proportion of older versus younger children in a sample may influence the degree of fearfulness or "bias" found in relation to certain stimuli.

The influence of family variables on cognition may also be affected by development. Given their greater dependence on parents, the role of the family in threat perception and response choice is likely heightened in younger anxious children relative their older counterparts [11,16]. Potential interpersonal mechanisms include families modeling certain information processing biases, parents overprotecting the child (thus inadvertently signaling that the child is not safe), attachment influences on the development of executive functions and coping style, and inadvertent parental reinforcement of avoidant child behavior. To avoid blaming parents, it is important to recognize the bidirectional nature of these influences (e.g., anxious children may appear vulnerable and elicit parental protection, as well as becoming anxious in response to this parental behavior) and the possible role of genetics or gene-environment interactions in the development of anxious cognitions.

Salience of findings

Some cognitive findings are interesting, but need to be interpreted with caution. As most studies are cross sectional, it is not always clear whether a cognitive difference between anxious and non-anxious children represents a factor that contributes to anxiety, maintains anxiety, is a product of anxiety, or is an epiphenomenon of anxiety. One of the few longitudinal studies in the field found that threat interpretation was relatively stable over time but anxiety scores predicted change in threat interpretation over time and distress anticipation predicted change in anxiety symptoms over time [53]. Thus, some influences between cognitive biases and anxiety appear to be reciprocal, so biases do not necessarily cause anxiety. Moreover, statistically significant findings do not always represent clinically significant findings [11]. For example, some children perform poorly on a laboratory task but cope well in day to day situations, or vice versa. It is also sometimes unclear how specific certain findings are. Some cognitive features of anxious children have been found in depressed children as well, some occur in children with diagnosed anxiety disorders but not in those who merely have elevated anxiety symptoms, and some appear specific to certain disorders or certain comorbidities [3,7]. In particular, comparisons between anxious and non-anxious children that neglect to include another clinical comparison group do not necessarily yield results that are specific to anxious children.

More to Learn

Recent reviews have highlighted further conceptual and methodological issues in the literature requiring clarification [3,11]. Some key issues include: the need to clarify the role of state anxiety in relation to biased cognition (i.e., some threat biases are only evident when research participants are stressed, and state anxiety may tap different aspects of information processing than trait anxiety); the need to clarify whether anxious children truly show heightened attention to threat or rather struggle to disengage from threat; the need to better distinguish information processing patterns in children with anxiety disorders from those in children with high trait anxiety; improving the reliability of research measures (which often exist in several versions); and better accounting for reporting biases (e.g., when relating performance on cognitive tasks with anxiety symptom scores on questionnaires).

Possible implications

All cognitive findings in this population must be interpreted through a developmental lens. For the clinician, treatment in young anxious children may need to emphasize the development of emotional understanding, de-emphasize executive function abilities, and constructively involve families. Conversely, intervention with adolescents may need to respect their developing executive functions (e.g., focus on hypothesis-testing rather than reassuring statements), attend to social as well as physical threats, and involve families to a lesser degree when developing emotion regulation skills. Anxious or overprotective parents may need encouragement and practice to recognize their children's strengths, positively reinforce approach behaviors, and assume their children can cope with feared situations. Addressing parental cognitive biases may also be helpful in some cases. The cross-sectional nature of most studies, uncertainty about the clinical significance and specificity of some findings, and the ongoing need for enhanced conceptual and methodological clarity all suggest that caution is warranted when interpreting new findings.

Conclusion: what changes in clinical practice are indicated?

Table 1 summarized the possible clinical implications of findings reviewed in this paper. Overall, these suggest that knowledge of anxious children's cognitive profiles may

assist in treatment planning, especially when keeping developmental factors in mind, and this knowledge is likely to become increasingly relevant to practice in the future. Although much of the literature focuses on information processing biases in anxious children, understanding their cognitive strengths and difficulties can be equally important, especially when recommending cognitively demanding treatments such as CBT. The bi-directional relationship between cognitive deficits and anxiety suggests thorough cognitive as well as psychiatric evaluation when child anxiety occurs mainly or exclusively in academic settings. Of all cognitive biases, those involving threat-biased attention appear particularly resistant to change with CBT, likely because they are minimally amenable to conscious control. Treatment specific to these biases (termed ABMT) has recently been developed and evaluated to aid children with poor response to traditional therapies. Although initial results appear promising, the potential risks, benefits, and optimal role of ABMT in relation to other evidence-based treatments await further clarification. For the future, cognitive discoveries offer the hope of individualizing psychological interventions to best suit anxious children's cognitive abilities and differences. In the meantime, it is advisable to use treatments that are supported by evidence, keep abreast of new findings, interpret these with caution, and humbly admit that we have much to learn.

References

[1] Daleiden E.L., Vasey M.W., An information-processing perspective on childhood anxiety, Clin. Psychol. Rev., 1997, 17, 407-429
[2] Crick N.R. Dodge K.A., A review and reformulation of social information-processing mechanisms in children's social adjustment, Psychol. Bull., 1994, 115, 74-101
[3] Puliafico A.C. Kendall, P.C., Threat-related attentional bias in anxious youth: a review, Clin. Child Fam. Psychol. Rev., 2006, 9, 162-180
[4] Seligman L.D., Ollendick T.H., Cognitive-behavioral therapy for anxiety disorders in youth, Child Adolesc. Psychiatr. Clin. N Am., 2011, 20, 217-38
[5] Mugnaini D., Lassi S., La Malfa G., Albertini G., Internalizing correlates of dyslexia, World J. Pediatr., 2009, 5, 255-64
[6] Grover R.L., Ginsburg G.S., Ialongo N., Psychosocial outcomes of anxious first graders: a seven-year follow-up, Depress. Anxiety, 2007, 24, 410-20
[7] Manassis K., When attention-deficit/hyperactivity disorder co-occurs with anxiety disorders: effects on treatment, Expert Rev. Neurother., 2007, 7, 981-988
[8] Shechner T., Britton J.C., Pérez-Edgar K., Bar-Haim Y., Ernst M., Fox N.A., et al., Attention biases, anxiety, and development: toward or away from threats or rewards?, Depress. Anxiety, 2012, 29, 282-294
[9] Waters A.M., Lipp O.V., Spence S.H., Attentional bias toward fear-related stimuli: an investigation with nonselected children and adults and children with anxiety disorders, J. Exp. Child Psychol., 2004, 89, 320-337
[10] Watts S.E., Weems C.F., Associations among selective attention, memory bias, cognitive errors and symptoms of anxiety in youth, J. Abnorm. Child Psychol., 2006, 34, 841-852
[11] Alfano C.A., Beidel D.C., Turner S.M., Cognition in childhood anxiety: conceptual, methodological, and developmental issues, Clin. Psychol. Rev., 2002, 22, 1209-1238
[12] In-Albon T., Dubi K., Rapee R.M., Schneider S., Forced choice reaction time paradigm in children with separation anxiety disorder, social phobia, and nonanxious controls, Behav. Res. Ther., 2009, 47, 1058-1065
[13] Cannon M.F., Weems C.F., Cognitive biases in childhood anxiety disorders: do interpretive and judgment biases distinguish anxious youth from their non-anxious peers?, J. Anxiety Disord., 2010, 24, 751-758
[14] Calamari J.E., Hale L.R., Heffelfinger S.K., Janeck A.S., Lau J.J., Weerts M.A., et al., Relations between anxiety sensitivity and panic symptoms in nonreferred children and adolescents, J. Behav. Ther. Exp. Psychiatry, 2001, 32, 117-136
[15] Carthy T., Horesh N., Apter A., Edge M.D., Gross J.J. Emotional reactivity and cognitive regulation in anxious children, Behav. Res. Ther., 2010, 48, 384-393
[16] Barrett P.M., Rapee R.M., Dadds M.R., Ryan S.M., Family enhancement of cognitive style in anxious and aggressive children: threat bias and the FEAR effect, J. Abnorm. Child Psychol., 1996, 24, 187-203
[17] Treadwell K.R., Kendall P.C., Self-talk in youth with anxiety disorders: states of mind, content specificity, and treatment outcome, J. Consult. Clin. Psychol., 1996, 64, 941-950
[18] Kley H., Tuschen-Caffier B., Heinrichs N., Safety behaviors, self-focused attention and negative thinking in children with social anxiety disorder, socially anxious and non-anxious children, J. Behav. Ther. Exp. Psychiatry, 2012, 43, 548-555
[19] Schmitz J., Kramer M., Tuschen-Caffier B., Negative post-event processing and decreased self-appraisals of performance following social stress in childhood social anxiety: an experimental study, Behav. Res. Ther., 2011, 49, 789-795
[20] Tuschen-Caffier B., Kühl S., Bender C., Cognitive-evaluative features of childhood social anxiety in a performance task, J. Behav. Ther. Exp. Psychiatry, 2011, 42, 233-239
[21] Szabó M., Lovibond P.F., The cognitive content of thought-listed worry episodes in clinic-referred anxious and nonreferred children, J. Clin. Child Adolesc. Psychol., 2004, 33, 613-622
[22] Legerstee J.S., Garnefski N., Jellesma F.C., Verhulst F.C., Utens E.M., Cognitive coping and childhood anxiety disorders, Eur. Child Adolesc. Psychiatry, 2010, 19, 143-150
[23] Manassis K., Tannock R., Young A., Francis-John S., Cognition in anxious children with attention deficit hyperactivity disorder: a comparison with clinical and normal children, Behav. Brain Funct., 2007, 3, 4

[24] Beitchman J. H., Wilson B., Johnson C. J., Atkinson L., Young A., Adlaf A., et al., Fourteen-year follow-up of speech/language-impaired and control children: psychiatric outcome, J. Am. Acad. Child Adolesc. Psychiatry, 2001, 40, 75-82

[25] Waters A.M., Craske M.G., Bergman R.L., Treanor M., Threat interpretation bias as a vulnerability factor in childhood anxiety disorders, Behav. Res. Ther., 2008, 46, 39-47

[26] Cartwright-Hatton S., Tschernitz N., Gomersall H., Social anxiety in children: social skills deficit, or cognitive distortion?, Behav. Res. Ther., 2005, 43, 131-141

[27] Hunt C., Keogh E., French C.C., Anxiety sensitivity, conscious awareness and selective attentional biases in children, Behav. Res. Ther., 2007, 45, 497-509

[28] Roy A.K., Vasa R.A., Bruck M., Mogg K., Bradley B.P., Sweeney M., et al., Attention bias toward threat in pediatric anxiety disorders, J. Am. Acad. Child Adolesc. Psychiatry, 2008, 47, 1189-1196

[29] Lester K.J., Field A.P., Oliver S., Cartwright-Hatton S., Do anxious parents interpretive biases towards threat extend into their child's environment?, Behav. Res. Ther., 2009, 47, 170-174

[30] Lupien S.J., Maheu F., Tu M., Fiocco A., Schramek T.E., The effects of stress and stress hormones on human cognition: Implications for the field of brain and cognition, Brain Cog., 2007, 65, 209–237

[31] Manassis K., Tannock R., McInnes A., Garland E.J., Clark S., Minde K., The sounds of silence: language, cognition and anxiety in selective mutism, J. Am. Acad. Child Adolesc. Psychiatry, 2007, 46, 1187-1195

[32] Martin L.T., Kubzansky L.D., LeWinn K.Z., Lipsitt L.P., Satz P., Buka S.L., Childhood cognitive performance and risk of generalized anxiety disorder, Int. J. Epidemiol., 2007, 36, 769-775

[33] Manassis K., Generalized anxiety disorder in the classroom, Child Adolesc. Psyciatr. Clin. N. Am., 2012, 21, 93-103

[34] Legerstee J.S., Tulen J.H., Dierckx B., Treffers P.D., Verhulst F.C., Utens E.M., CBT for childhood anxiety disorders: differential changes in selective attention between treatment responders and non-responders, J. Child Psychol. Psychiatry, 2010, 51, 162-172

[35] Manassis K., Hum K.M., Lee T.C., Zhang G., Lewis M.D., Threat perception predicts cognitive behavioral therapy outcomes in anxious children, Open J. Psychiatry, 2013, in press

[36] Lau W.Y., Chan C.K., Li J.C., Au T.K., Effectiveness of group cognitive-behavioral treatment for childhood anxiety in community clinics, Behav. Res. Ther., 2010, 48, 1067-1077

[37] Manassis K., Wilansky-Traynor P., Farzan N., Kleiman V., Parker K., Sanford M., The feelings club: randomized controlled evaluation of school-based CBT for anxious or depressive symptoms, Depress. Anxiety, 2010, 27, 945-952

[38] Creswell C., Schniering C.A., Rapee R.M., Threat interpretation in anxious children and their mothers: comparison with nonclinical children and the effects of treatment, Behav. Res. Ther., 2005, 43, 1375-1381

[39] Waters A.M., Wharton T.A., Zimmer-Gembeck M.J., Craske M.G., Threat-based cognitive biases in anxious children: comparison with non-anxious children before and after cognitive behavioural treatment, Behav. Res. Ther., 2008, 46, 358-374

[40] Macleod C., Cognitive bias modification procedures in the management of mental disorders, Curr. Opin. Psychiatry, 2012, 25, 114-120

[41] Hallion L.S., Ruscio A.M., A meta-analysis of the effect of cognitive bias modification on anxiety and depression, Psychol. Bull., 2011, 137, 940-958

[42] Eldar S., Apter A., Lotan D., Edgar K.P., Naim R., Fox N.A., et al., Attention bias modification treatment for pediatric anxiety disorders: a randomized controlled trial, Am. J. Psychiatry, 2012, 169, 213-220

[43] Rozenman M., Weersing V.R., Amir N., A case series of attention modification in clinically anxious youths, Behav. Res. Ther., 2011, 49, 324-330

[44] Bar-Haim Y., Morag I., Glickman S., Training anxious children to disengage attention from threat: a randomized controlled trial, J. Child. Psychol. Psychiatry, 2011, 52, 861-869

[45] Waters A.M., Pittaway M., Mogg K., Bradley B.P., Pine D.S., Attention training towards positive stimuli in clinically anxious children, Dev. Cogn. Neurosci., 2012, doi: 10.1016/j.dcn.2012.09.004 [Epub ahead of print]

[46] Lee T.C., Dupuis A., Guberman C., Jones E., Herbert M., Manassis K., Effects of age and subtype on anxious children's emotional recognition: Implications for cognitive-behavioural therapy, Can. J. Psychiat., in press

[47] Comer J.S., Kendall P.C., A symptom-level examination of parent-child agreement in the diagnosis of anxious youths, J. Am. Acad. Child Adolesc. Psychiatry, 2004, 43, 878-886

[48] Flavell J.H.H., Flavell E.R., Green F.L., Developments of children's understanding of connections between thinking and feeling, Psychol. Sci., 2001, 12, 430-432

[49] Pearson D.A., Lane, D.M., Visual attention movements: a developmental study, Child Dev., 1991, 61, 1779-1795

[50] Rosso I.M., Young A.D., Femia L.A., Yurgelun-Todd D.A., Cognitive and emotional components of frontal lobe functioning in childhood and adolescence, Ann. NY Acad. Sci., 2004, 1021, 355-362

[51] Westenberg P.M., Drewes M.J., Goedhart A.W., Siebelink B.M., Treffers P.D., A developmental analysis of self-reported fears in late childhood through mid-adolescence: social-evaluative fears on the rise?, J. Child Psychol. Psychiatry, 2004, 45, 481-495

[52] Muris P., Mayer B., Freher N.K., Duncan S., van den Hout A., Children's internal attributions of anxiety-related physical symptoms: age-related patterns and the role of cognitive development and anxiety sensitivity, Child Psychiat. Hum. D, 2010, 41, 535-548

[53] Cresswell C., O'Connor T.G., Interpretation bias and anxiety in childhood: stability, specificity and longitudinal associations, Behav. Cogn. Psychother., 2011, 39, 191-204