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ORIGINAL ARTICLE

Childhood Fears, Neurobehavioral Functioning and Behavior Problems in School-Age Children

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Abstract The objective is to examine underlying associations between childhood fears, behavior problems and neurobehavioral functioning (NBF) in school-age children. Healthy, regular school children ($N = 135$), from second, fourth and sixth grade classes were assessed. Data regarding children's fears and behavioral problems were obtained with the Revised Fear Survey Schedule for Children, the Child Behavior Checklist, and NBF was assessed using a computerized neurobehavioral evaluation system. Significant correlations between childhood fears and NBF measures and somatic complaints were found. Children who reported higher levels of fears demonstrated lower working memory span ($r = 0.24$, $p < 0.05$), lower motor speed ($r = -0.23$, $p < 0.05$), and had more somatic complaints ($r = 0.20$, $p < 0.05$). Furthermore, younger children reported less fears than older ones and girls reported more fears than boys. These results highlight significant association between childhood fears, NBF and behavior problems in a non-clinical group children. Lower working memory span is an important component of executive control that may be an underlying factor in fears and anxiety in children.

Keywords Fears · Children · Neurobehavioral · Behavior problems · Memory · Motor

Introduction

Past studies on prevalence of fears and anxiety in children and adolescents have shown that childhood fears are quite common [1, 2]. Although the terms *fear* and *anxiety* are frequently employed interchangeably, an examination of the literature indicates that both

This was not an industry supported study.

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concepts are quite different in terms of their manifestation, function, and biological underpinning [3, 4]. In this study, we refer to *normal fears*, defined as a normal reaction to a real or imagined specific threat, and considered to be an integral and adaptive aspect of development [5, 6].

Studies of normal childhood fears have relied mainly on surveys that consist of a wide range of potentially fear-provoking stimuli and situations, such as the widely used revised version of the Fear Survey Schedule for Children (FSSC-R) [7]. The most common fears among non-clinical youths as shown in Various FSSC-R studies are related to physical harm or animals [8–13].

Research has shown that girls at all ages report higher levels of fear and anxiety than boys [9, 14–18]. Although research clearly show that there are gender differences in all ages, in self-reported fear and anxiety, it should be noted that these differences are less clear-cut when using parents as raters of children's symptoms [19].

Fear and anxiety are normal phenomena that occur in many children and adolescents. However, there are findings indicating that symptoms of childhood fears and anxiety are often seriously disturbing, distressing and are manifested by aversive thoughts and avoidance behavior [20]. Ollendick and King [21] found that a large majority of children (i.e., more than 60%) reported that their fears interfered substantially with daily activities. Other studies found that in nonclinical youths fear and anxiety symptoms were accompanied by various emotional, social, and behavioral problems [22–26].

Neurobehavioral Functioning (NBF), which refers to cognitive, motor, attention, and learning skills) has been repeatedly associated with psychopathology [27–31]. However, the research on the links between childhood fears and attentional control and other cognitive skills has been very sparse. In recent years, excessive fears, phobia and other anxiety disorders have been linked to attentional control and biases in both children and adults [31–38]. These processes play a major role because attention selectively facilitates the early processing of threat, thereby influencing subsequent cognitive and emotional processes related to anxiety [39–41].

Recently, Espy and Bull [42] have reported that working memory span is associated with children's ability to control attention. In contrast to children with higher working memory spans, children with lower working memory spans were less able to inhibit an internally represented rule or response set that had been previously active or were less proficient in disengaging and controlling attention, which then interfered with the child's ability to engage and implement a newly relevant response or rule [42]. Thus, we hypothesized that fearful children would have compromised working memory span.

The purpose of the present study was to assess the links between NBF, behavior problems and childhood fears in a non-referred group of school aged children. Three distinct age groups provided a developmental perspective. Our hypotheses were: (a) More fearful children will demonstrate compromised NBF (specifically working memory span); and (b) More fearful children will express more behavioral problems associated with anxiety.

Methods

Participants

One hundred and thirty-five children, 69 boys and 66 girls, participated in the study. The children were sampled from three distinct age groups: 2nd grade ($N = 48$; age

range = 7.2–8.6 years; mean = 7.9; SD = 0.34), 4th grade ($N = 36$; age range = 9.3–10.4 years; mean = 9.7; SD = 0.30); and 6th grade ($N = 51$; age range = 11.2–12.7 years; mean = 11.8; SD = 0.45).

The study was approved and supported by the Israel Ministry of Education. It was defined by the school authorities as a school project and informed consent was obtained from the children and their parents. Each child was rewarded with a small gift for completing the study. The recruitment efforts led to above 95% consent rate in all classes involved. Our goal was to assess a broad picture in total class samples of healthy school children, and therefore only narrow exclusion criteria were employed. Only children with acute physical illness or children receiving medication were excluded from the study.

The sample consisted mostly of children from middle to upper class families. Most of the parents had a full-time job (fathers: 89.4%; mothers: 45.1%) and high level of education (mean number of years of formal education = 14.7, range = 8–24). Most of the children (92.5%) were living with both parents in relatively small households (mean number of family members = 4.7, range = 2–9). Thirty-eight percent of the children were firstborn.

Procedures

Following the informed consent by child and parents, the parents were asked to complete a battery of questionnaires that included family background material and the Child Behavior Checklist [43]. Within 2–4 weeks following the completion of the questionnaires, each child's NBF was evaluated. Over the course of the same week, each child was tested twice with the Neuropsychological Evaluation System (NES) [44, 45] in school. The first NBF test was administered at one of two testing times (Morning 8.00–9.00 a.m. or 12 Noon–13.00 p.m.), chosen randomly for each child. The second test was performed 3–4 days later at the complementary time (e.g., a child that was first tested in the morning performed his/her second test at noon and vice versa). Both morning and noon administrations were conducted during regular class hours (test duration: 30–45 min). Testing children during special class activities was avoided to prevent motivational biases.

In addition, children were asked to complete the FSSC-R [7, 8, 14]. The questionnaire was translated to Hebrew and adapted to Israel by adding some local fears related to war and terror-related threats (e.g., fear of terror attacks, fear of wars).

Measures

The assessment of children's fears was based on the Israeli version of the FSSC-R. FSSC-R includes 70 items taken from the original versions and its subsequent versions. Items were selected and additional items were added that seemed more appropriate for a sample of Israeli children. Children were asked to rate, on a 1–5 scale (1 = not scary at all 5 = very scary), their level of fear on items such as ghosts, snakes, being punished by mother, etc. Adding the scores for all responses across the 70 items yields the Total Fear Score reflecting a global index of fear level. The selected FSSC-R items were translated to Hebrew and in a preliminary study the test–retest Cronbach score was (0.79) [46].

The Neurobehavioral Evaluation System (NES) has been established for screening compromised neurobehavioral functioning [45]. The NES was originally developed for adults but it has been successfully used with school-age children and validated as a good predictor of attention difficulties associated with school performance [44, 47–49]. Arcia et al. [44] assessed 105 children aged 7–10 years using selected tests from the NES as well

as other class behavior measures and academic achievements. NES measures were found to be highly predictive of school achievements and class behaviors, such as attentional skills and independent functioning.

For the present study the NES was installed on a Compaq notebook computer (Contura model) and the tests were administered by research assistants (students of psychology), individually for each child, twice within a week period.

In this study, we calculated a variable that reflected the average sum of the two testing times for each of the NBF measures. The children were tested using six age-appropriate tests: (1) Finger Tapping: The child is requested to tap as fast as possible with one finger on a single button. This test examines motor speed. The measure used is the maximum number of taps separately for each hand. (2) Simple Reaction Time Test: The child is requested to press a button as quickly as possible when a large square appears on the screen. The inter-trial is varied randomly to reduce effects of stimulus anticipation. The measure used is reaction time. (3) Continuous Performance Test (CPT): Measures sustained visual attention. Different graphic images of animals are presented on the screen at varying time intervals and the child is required to respond as fast as possible when a cat is presented and not respond to any other animal. The measures include response time, omission errors (not responding to the cat) and commission errors (responding to other animals). Test duration was 10 min. (4) Symbol-Digit Substitution (SDS): A computerized version of the SDS (similar to the paper and pencil version included in WISC-R). Nine symbols and nine digits are paired at the top of the screen and the child is requested to press the digits on the keyboard corresponding to a test set of the nine symbols presented in a mixed order. Six sets of nine symbol-digit pairs are presented in succession. Measures: Average response latency (in seconds) for completing each set. (5) Visual Digit Span Test: The child is presented with a sequence of digits on the screen and is then required to repeat the sequence on the computer keyboard (forward). Longer spans are increasingly presented until the child makes two errors a span length. Once the child completes this task and reaches the two-error limit, the test is repeated with new sets of digits, however s/he is required to enter the digits in reverse order (backward). Measures include the lengths of the longest span answered correctly forward and backward. (6) Serial Digit Learning Test: A long sequence of single digits is presented in succession and the child is requested to recall as many of the digits as possible. The same sequence of digits is presented again until either the child recalls the entire sequence correctly (two trials in a row) or the maximum of eight trials is reached. Measure: an error score that is the sum of the errors over all trials attempted. One point is added for a "nearly correct" answer (two-thirds of the digits entered correctly) and two points are added for a worse response.

The reliability of the NES measures was tested using test-retest Pearson correlations between the first and the second administration for each child. High reliabilities were found on the SDS reaction time ($r = 0.93$), finger tappings (0.80), CPT reaction time (0.79), simple reaction time (0.72), and CPT commission errors (0.71). Lower test-retest correlations were found for the digit backward (0.61), SDS error score (0.50), CPT omission errors (0.45), and digit forward (0.42). All test–retest correlations were significant ($p < 0.0001$) [50].

The Child Behavior Checklist (CBCL) was used to assess behavior problems as perceived by parents [43]. The CBCL is a widely-used instrument for assessing behavior problems with well-established psychometric properties. The Hebrew version of this instrument has been translated and validated in Israel [51].

Results

To test the influence of class and gender on the total fear score a two way ANOVA was performed: a significant main effect was found for gender, influencing the total fear score $F(1, 116) = 12.34$, $p < 0.001$), showing that the total fear score for girls ($M = 2.88$, SD = 0.55) was significantly higher than for boys ($M = 2.51$, SD = 0.64).

In addition, a significant main effect was found for class influencing the total fear score $F(2, 116) = 4.26$, $p < 0.05$), such that children in the 2nd grade had significantly higher total fear score ($M = 2.89$, SD = 0.64) than children in the 6th grade ($M = 2.53$, $p < 0.05$), but no significant difference was found on the total fear score between children in the 2nd and 4th grades ($M = 2.62$, SD = 0.65) and between children in the 4th and 6th grade.

No significant interaction effect was found between gender and class influencing the total fear score [$F(2, 116) = 0.25$, n.s] (see Fig. 1).

Before assessing the correlations between the fears and NBF measures, the anticipated correlations between these measures and age were assessed [50]. All the NBF measures were significantly correlated with age in the direction of improved performance with age: SDS response latency ($r = -0.76$), finger tappings (0.52), simple reaction time (−0.58), CPT reaction time (−0.62), CPT commission errors (−0.36), CPT omission errors (−0.33), digit backward (0.51), digit forward (0.51), and digit learning error score (−0.51); all correlations were significant at $p < 0.0001$.

Partial Pearson correlations were calculated between the total fear score and NBF measures for the total sample, with age and gender partialled out. The results indicated that after controlling for age and gender there were low but significant correlations between the total fear score and Finger Tapping (dominant hand) ($r = -0.23$, $p < 0.05$), and serial digit learning ($r = 0.24$, $p < 0.05$). No, other significant correlations were found.

Partial Pearson correlation between CBCL scores and the total fear score, controlling for age and gender, revealed only a low but significant correlation with somatic complaints ($r = 0.20$, $p < 0.05$). No, other significant correlations were found.

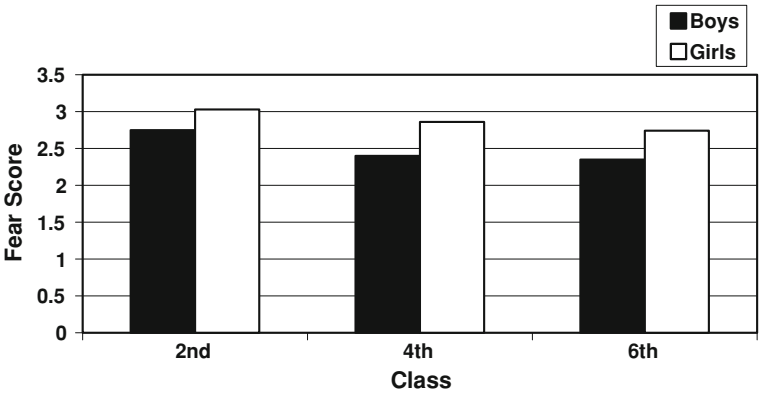

Fig. 1 Total fear score by class and gender

Discussion

The main aim of this study was the exploration of the links between childhood fears and several NBF measures. We were especially interested in the associations between fears and working memory span measures.

The main contribution of this study, as hypothesized, is that children who reported higher fear level were less successful on the working memory span task (digit learning). This task has been associated with attention control [42]. This finding lends initial support to our hypothesis regarding the underlying links between attention control, working memory and childhood fears. It has been demonstrated that attentional control, play an important role in the pathogenesis of childhood anxiety disorders [52–54].

Given the vast literature highlighting the link between lower executive abilities (such as planning, shifting and inhibition skills) to the etiology of diverse clinical disorders [27, 29, 30, 55–57], we assume that future studies will reveal other compromised executive abilities in fearful children compared to less fearful children.

The second important finding was that children who reported higher fear level also exhibited slower motor responses. This finding is in line with reports on "soft signs" in children at-risk for anxiety disorders [58]. Children of agoraphobic adults had significantly more right- and left-side motor slowness on finger tapping and hand patting than did children of controls. Other studies found evidence linking both childhood and adult anxiety and neurological "soft signs" [59–63].

Interestingly, Butler et al. [64] found decreased activity of primary motor cortex and increased activity in dorsal basal ganglia during anticipation of aversive stimulation. These researches concluded that this pattern can be interpreted as reflecting a shift from cortical to subcortical processing during danger. This activity can range from voluntary or semi-voluntary "top down" activities such as tensing of muscles to more automatic "bottom up" fear related motor processes such as fear-potentiated startle and fear-induced freezing which have been to neuropsychiatric disorders. It could be speculated that more fearful children are prone to react in "bottom up" style, showing a decrease in motor activity which reflects a distinct pathological coping style in a non-dangerous situation. Clearly, this speculation requires further research and validation in clinical samples.

Surprisingly, we only found one small but significant association between childhood fears and CBCL scale. Children who reported higher fear level were reportedly presenting more somatic complaints [65–67]. This finding suggests that parents do not necessarily detect behavior problems in fearful children and the main manifestation of their fears is somatization.

Finally, our results also replicated established developmental features of childhood fears. Older children (6th grade) reported more fears that younger children (2nd grade) [68, 69]. Furthermore, girls in our study demonstrated higher level of fears than boys [9, 14–18].

One limitation of the study is that the significant correlations found, between fears and NBF were relatively small, but this is not surprising considering the fact that NBF is affected by multiple factors including the length of the tests, motivation, feedback and physiological state [50].

A second limitation is the correlational nature of our study, which makes causal inferences speculative and tentative. Thus, alternative explanations for our results are plausible. For example, it might be that fear and anxiety interfere and influence the attentional system and not the opposite [70].

In conclusion, our results highlight the association between childhood fears, NBF and specific behavior problems in a non-clinical group of typically developing children. Clearly, further research is needed in order to validate our findings in both clinical and non-clinical samples.

Summary

The research on the links between childhood fears and attentional control and other cognitive skills has been very sparse. This study examined underlying associations between childhood fears, behavior problems and neurobehavioral functioning (NBF) in school-age children.

Significant correlations between childhood fears and NBF measures and somatic complaints were found. Children who reported higher levels of fears demonstrated lower working memory span ($r = 0.24$, $p < 0.05$), lower motor speed ($r = -0.23$, $p < 0.05$), and had more somatic complaints ($r = 0.20$, $p < 0.05$). Furthermore, younger children reported less fears than older ones and girls reported more fears than boys. These results highlight significant association between childhood fears, NBF and behavior problems in a non-clinical group of typically developing children. Lower working memory span is an important component of executive control that may be an underlying factor in fears and anxiety in children. Clearly, further research is needed in order to validate our findings in both clinical and non-clinical samples.

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Conflict of interest statement The authors have no financial conflict of interest to report.

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