Introduction

An information-processing perspective has been explicitly adopted by several researchers in order to organize the extensive (and often controversial) evidence supporting anxious children‟s cognitive biases in processing emotional information (Daleiden & Vasey, 1997; Pine, 2007). Such integrative approaches are essential in order to investigate vulnerability markers that contribute to the development and maintenance of child and adolescent psychopathology (Ingram & Price, 2010; Muris, 2006). So far, most of the developmental work has been channeled into identifying adultlike attentional biases towards threat and threat appraisal distortions. Studies looking at the "emotional capture" of attention in both nonclinical (state or trait) high anxious (HA) and clinically anxious children revealed that, compared to low-anxious (LA) participants, they display an attentional bias towards threatening information (see Hadwin & Field, 2010; Visu-Petra, Cheie, & Miu, in press; for recent reviews). A similar bias was evidenced in the analysis of threat appraisal processes in HA children, who present stable, trait-like tendencies to classify a wide range of stimuli as potentially harmful (e.g. Muris, Meesters, Smulders, & Mayer, 2005). However, little is known about a potential path between the two; in other words, how attentional biases might relate to the enduring, "looming" cognitive style, characterizing anxiety across the lifespan (Riskind, 1997). Pine (2007) hypothesized an interaction between attentional biases which occur in the early stages of information processing and subsequent learning processes which lead children to classify a broad range of stimuli as dangerous, generating their documented threat appraisal biases. Similar to this line of reasoning, Weems and Watts (2005) theorized that selective attention would foster a memory bias by limiting available 4 information for memory storage towards threat information; in turn, the memory biases would foster interpretive biases such as negative cognitive errors. Finally, the presence of a delayed memory bias towards negative information in HA preschoolers would constitute an important "milestone" in the learning of fearful schema throughout childhood, leading to increased behavioural avoidance and fear beliefs (Field & Lester, 2010). The Attentional Control Theory (ACT, Eysenck, Derakshan, Santos, & Calvo, 2007) makes a series of relevant predictions on the detrimental impact of anxiety upon cognitive performance, most of them being already validated in adult and developmental samples (see Derakshan & Eysenck, 2009; Visu-Petra et al., in press; for reviews). According to ACT, anxiety mainly disrupts performance on tasks tapping the inhibition, shifting, and (to a lesser extent) updating functions and that these effects, if visible, should impact processing efficiency (response time, mental effort) to a greater extent than processing effectiveness (accuracy). An incorporation of ACT‟s predictions regarding memory performance, would suggest a greater impact of anxiety upon performance on tasks requiring higher demands on the updating function (i.e. on working memory tasks). However, research has found that anxiety‟s negative effects were also present on performances on short-term memory (STM) tasks, especially when task efficiency (response time) was assessed (e.g. Derakshan & Eysenck, 1998; Richards, French, Keogh, & Carter, 2000; Hadwin, Brogan, Stevenson, 2005; Visu-Petra, Miclea, Cheie, & Benga, 2009; Visu-Petra, Cheie, Benga, & Alloway, 2011). With respect to the emotional value of the stimuli, ACT suggests that cognitive performance is influenced by stimulus valence, anxiety‟s deleterious effects being greater when task stimuli themselves are 5 threat-related. It is presumed that anxious individuals‟ impaired cognitive performance on tasks involving threat related stimuli is explained by the combination of impaired attentional control and preferential processing of threat related stimuli (Eysenck et al., 2007). Although no direct predictions are made concerning long-term recall of emotionrelated stimuli, the above mentioned presumption might suggest a preferential recall of threat-related stimuli. Developmental evidence Looking at developmental research, the evidence regarding HA children‟s memory for emotional information is scarce and inconsistent (see Hadwin, Garner, & PerezOlivas, 2006, for a review). Only two studies looked at short-term verbal recall for emotional information in non-clincal samples. Daleiden (1998) investigated the effects of trait anxiety on a conceptually and perceptually cued declarative memory task in a sample of school-age children (mean age = 12 years). The study involved children memorizing two sets of words (positive, negative, neutral). The findings revealed that recall of negative (versus positive and neutral) words was heightened in the HA group, only when recall involved conceptual (versus perceptual) memory cues. Reid, Salmon & Lovibond (2006) investigated different cognitive biases in a non-clinical sample of school-age children rated for anxiety, depression, and aggression. Results indicated a memory bias towards negative information only when scores from all types of symptoms were combined, and no specific association with anxiety symptoms. To our knowledge, there is no study investigating both immediate and delayed recall of words with different emotional valences in HA children. 6 Looking at visual recognition of emotional information, developmental researchers used emotional facial expressions as ecologically valid, salient stimuli even for very young children (McClure, 2000), although the ability of affective pictures to elicit discrete emotions has been questioned (Thibodeau, Jorgensen, & Jonovich, 2008). In a visual search task with memory updating demands (testing immediate recognition), Visu-Petra, Ţincaş, Cheie, & Benga (2010) found that compared to LA children, HA children were slower and less accurate in recognizing previously seen identities displaying happy expressions, but more accurate in responses to identities expressing anger. Looking at within-group differences according to stimulus valence, LA children were less accurate in response to identities expressing anger (relative to identities displaying happy, and neutral expressions), while HA children were less accurate in response to identities displaying happy (relative to neutral) expressions. These results confirm previous findings from research with adult participants (Moser, Huppert, Duval, & Simons, 2008; Silvia, Allan, Beauchamp, Masehauer, & Workman, 2006), revealing a positive recognition bias for LA participants, and a negative bias in HA children, favoring the recognition of identities expressing anger. The present study The aim of the present study was to investigate the relationship between traitanxiety and explicit memory for task-irrelevant emotional information by focusing on an under-researched developmental period (3-7 years). There is evidence to show that the preschool years represent a period of intensive development in terms of executive functions (see Zelazo, Carlson, & Kesek, 2008), verbal and visual STM (e.g. Alloway, Gathercole, & Pickering, 2006), and memory strategies (e.g. Schneider, Kron, 7 Hunnerkopf, & Krajewski, 2004). Moreover, evidence suggests that during this period, there is also an intensive development of emotion understanding and use of emotional labels (e.g. Widden & Russell, 2003), as well as of memory for emotional information (see Paz-Alonso, Larson, Castelli, Alley, & Goodman, 2009 for a review). To our knowledge, this is the first study looking at both immediate and delayed verbal recall, along with delayed visual recognition of identities varying in emotional facial expressions in HA preschoolers. Furthermore, the current investigation is particularly relevant for understanding the developmental trajectory of anxiety, as evidence of early memory biases towards negative information would support the developmental continuity framework (Weems, 2008), that acknowledges the early onset of information processing biases in high-anxious children. There were several issues of interest. First, we wanted to investigate whether anxiety would impact effectiveness (accuracy) and/or efficiency (response time) performance measures, irrespective of stimulus valence. Our hypothesis, based on ACT predictions, was that overall accuracy would not significantly differ between HA and LA participants, considering that both tasks have low levels of executive demands, requiring simple information storage. However, HA children would have longer response times (efficiency costs) in order to ensure this comparable level of accuracy. Second, we wanted to investigate whether performance accuracy on the recall and recognition tests would differ between HA and LA participants as a function of stimulus emotional valence across both stimulus modalities (verbal and visual). In line with previous research, we expected enhanced memory for negative information and diminished memory for positive information in the HA sample, relative to LA participants on both 8 conceptual (verbal) and perceptual (pictorial) tasks. The impact of verbal (task-irrelevant) emotional information was also investigated as a function of retention period (immediate or delayed). Although the comparison between immediate and delayed effects is exploratory, we relied on the theoretical assumption (and the few empirical proofs) that the preferential attentional processing and/or difficulty disengaging from threat-related stimuli would generate both immediate, and delayed memory enhancements for negative information. Method Participants A total of 76 preschoolers (37 girls) recruited from three kindergartens in the northwest Romania participated in this study. The age range was between 45 and 85 months (mean age = 65.48 months, SD = 10.94). Parental informed consent was obtained before testing for all the children involved, as well as informed verbal assent from each child. From the total sample, 71 preschoolers completed the verbal memory tasks, while 76 completed the visual recognition task (71 children completing both tasks). Measures Individual differences in trait anxiety, were assessed via parental report on the Spence Preschool Anxiety Scale (Spence, Rapee, McDonald, & Ingram, 2001), built in accordance with DSM-IV diagnostic categories. The scale consists in 28 trait anxiety items, 5 nonscored posttraumatic stress disorder items, and another open-ended (nonscored) item. The parent is asked to rate on a five-point scale the concordance between their child‟s general behavior and the one described by the questionnaire items; an overall measure of trait anxiety is generated based on these ratings. The Romanian 9 version of the test (Benga, Ţincaş, & Visu-Petra, 2010) has good internal consistency (Cronbach‟s alpha = .87 for mother reports and Cronbach‟s alpha = .89 for father reports) and moderate test–retest reliability (r = .59). In order to assess immediate and delayed recall of affective words, we used a task modified from the List Learning task included in the NEPSY battery (Korkman, Kirk, & Kemp, 1998). The task contains two conditions: the Immediate List Learning condition, and the Delayed List Learning condition, assessing 30-minute delayed recall. The NEPSY List Learning task was modified so that it would: (a) be suitable for preschool children – the number of words included in the list was reduced to 9, while the number of times the list was repeated before the interference list (trials) was reduced to three; (b) contain words with different emotional valences: 3 negative, 3 positive, and 3 neutral words (see Appendix); (c) contain words with a maximum two syllables length. In order to generate the 9 word list, we gave 25 primary school children a list of 56 words extracted from the ANEW (Affective Norms for English Words; Bradley & Lang, 1999) in order to classify them as pleasant, unpleasant or neutral. For the List Learning, as well as for the interference one, we used the top most frequently classified words as belonging to one of the three valence categories. A modified version of the Memory for Faces task (NEPSY; Korkman et al., 1998) was used in order to assess delayed recognition of facial expressions. We modified the NEPSY task so that it would: (1) contain 9, instead of 15 faces; (2) contain 3 different emotional expressions: angry, happy, and neutral; (3) be administered in a computerized format for standardization purposes. We only used the Delayed condition, since the Immediate condition resulted in ceiling effects in a pilot study. Therefore, the child sees 9 10 facial expressions and after a 30-minutes delay he/she had to recognize the previously seen facial identities from 3 displays, each containing 3 more distracters. All stimuli in a display had the same emotional valence (angry, happy, or neutral) in order not to introduce competition among valence-related processes. For both the target items and the distracters, we used faces from the NimStim database (Tottenham et al., 2009) and Pictures of Facial Affect (POFA, Ekman & Friesen, 1976). Regarding the actual presentation of the target stimuli, 2 constraints were employed: (1) the valence of a stimulus was not repeated immediately; (2) an identical number of each stimulus valence occurred (3 angry, 3 happy, 3 neutral). Figure 1. Design of the Visual Recognition task. M = male, F = female, Ang = angry facial expression. Procedure and scoring Trait-anxiety scores. The Spence scale was rated by children‟s mothers, and a total trait-anxiety score was subsequently generated. For this sample, the scale had good internal consistency, Cronbach‟s alpha= .82. We performed a median split of children‟s total trait anxiety scores (median at 22). As a result, the children in our sample were classified as either high-anxious (HA; N = 38; mean Spence score = 34.11, SD = 13.66) 11 or low-anxious (LA; N = 38; mean Spence score = 13.47, SD = 4.85). While the two anxiety groups did not differ in age, $F(1, 74) = .79$, n. s. (mean age for HA = 66.61 months, SD = 12.41; mean age for LA = 64.37 months, SD = 9.28), or gender $F(1, 74) = .46$, n. s. (20 girls in the HA group, 17 in the LA group, respectively), the difference between their trait anxiety scores was highly significant, $F(1, 74) = 76.96$, $p < .01$, partial $\eta2 = .51$. Immediate and delayed recall of affective words. All tasks were individually applied in two different sessions, each lasting for about 30-35 minutes, and applied on two consecutive weeks. During the first session, the experimenter instructed the child that he/she would hear a list of words which should reproduce immediately. The list containing 9 words (3 positive, 3 negative, 3 neutral) was read at a rate of one word per second. After the third list repetition, an interference list was introduced (9 new words with the same three emotional valences, see Appendix). After reproducing the words from this new list, the children were asked to recall the words from the “old” list, without relistening to it. We calculated mean accuracy for each valence category across the first four lists (without the interference list). Finally, an index of efficiency of response (time taken to recall the words on the four lists, divided by the number of words recalled) were also computed. After the immediate memory trials, children were engaged in other cognitive tasks (picture naming, block construction) for about 30 minutes; then the Delayed condition of the List Learning task was applied. For this delayed condition, we again computed the accuracy of response as a total, as well as for each valence category. Delayed recognition of emotional facial expressions. At the beginning of the second session, the children were presented with the 9 pictures from our modified version 12 of the Memory for Faces Delayed task. The pictures were displayed on a computerized format (on a laptop computer with the resolution set to 1024 X 768 pixels) for 5 s each, with 2 s pause in between (the task was designed using the E-prime software, version 1.2.; Psychology Software Tools). The instruction the children received was to look at each picture and say if the person in it was a male or a female. This instruction was verbally presented by the experimenter and was followed by two learning trials. The stimuli presentation was followed by other cognitive tasks lasting for about 25-30 minutes, after which the children were engaged in the actual delayed recognition task. Similar to the scoring used for the Delayed List Learning task, a total index of accuracy and an accuracy index for each valence were calculated. Results Descriptive data for all study measures, according to anxiety group are presented in Table 1. First, we analyzed gender and age effects for the whole sample. No gender differences were found on the verbal recall tasks, $F(1, 70) = .01$, n. s. for Immediate recall, $F(1, 70) = .06$, n. s. for Delayed recall, or on the visual recognition task, $F(1, 75) = .30$, n. s. Correlation analysis revealed that age was significantly related to most of the study measures. Age (in months) was positively related to both Immediate recall, r(69) = .41, p < .01, and Delayed recall of words, r(69) = .34, p < .01. It was also negatively related to the efficiency index (time per words recalled), r(69) = -.35, p < .01), revealing that older children were faster in correctly recalling the test items. Age was also positively associated to the recognition of previously seen faces, r(74) = .29, p < .05. 13 Table 1. Descriptive statistics for study variables Anxiety group LA HA M SD M SD Age (Months) 64.37 9.28 66.61 12.41 Anxiety (Spence score) 13.47 4.85 34.11 13.66 Verbal Immediate Accuracy 4.32 1.47 3.85 1.36 Verbal Immediate RT (Seconds) 10.37 6.55 10.65 8.81 Verbal Delayed Accuracy 2.57 1.72 2.21 1.70 Visual Delayed Recognition Accuracy 6.68 1.38 6.47 1.62 Note: Verbal Immediate RT = Response times on the lists of the Immediate verbal recall task, divided by the number of words recalled. Given the heterogeneous age group, as well as the significant correlations found between age and the majority of the study measures, all subsequent analyses were conducted controlling for age. Associations within and between study measures (controlling for age) are displayed in Table 2. A significant negative correlation was found between Anxiety scores and performance accuracy for Delayed verbal recall, r(68) = -.28, p < .05, revealing that children who had higher anxiety scores, were also less accurate. There was a positive association between Immediate and Delayed verbal recall performance, r(68) = .55, p < .01. Looking at inter-task correlations between verbal and visual memory tasks, in terms of overall accuracy scores, no significant association was found. Overall efficiency in the Immediate recall task was negatively related to recall 14 accuracy indexes, r(68) = -.40, p < .01 for Immediate recall and , r(68) = -.32, p < .01 for Delayed recall, revealing that children who were faster in their responses, were also more accurate. Table 2. Intercorrelations between study measures, controlling for age Measures (2) (3) (4) (5) (1) Anxiety (Spence score) -.18 .15 -28* -.08 (2) Verbal Immediate Accuracy - -.40** .55** .12 (3) Verbal Immediate RT (Seconds) - -.32** -.08 (4) Verbal Delayed Accuracy - -.01 (5) Visual Delayed Recognition Accuracy - Note: Verbal Immediate RT = Response times on the lists of the Immediate verbal recall task, divided by the number of words recalled; *p < .05; **p < .01. Next, we analyzed performance accuracy on the verbal recall task, looking at the main effects and interactions between anxiety, age, memory condition and stimulus valence. Figure 2 displays the accuracy results from the Immediate and Delayed conditions according to stimulus valence and to anxiety group. We conducted a repeated measures analysis of covariance (ANCOVA) with memory condition (Immediate vs. Delayed) and stimulus valence (positive, negative or neutral) as within-subject factors. Anxiety group (HA vs. LA) represented the between-subjects measure, while Age was the covariate. Results pointed to a significant interaction between Memory condition and Valence, F (2, 134) = 9.26, p < .01, ηp 2 = .12, revealing that emotional words (both 15 positive and negative) were less well remembered in the Delayed, compared to the Immediate condition, while memory for neutral words did not deteriorate significantly after the 30-minute delay. We found a significant effect of Age, F(1, 68) = 16.60, p < .01, ηp 2 = .20, overall memory performance increasing with age. There was also a marginal effect of Anxiety group, F(1, 68) = 3.79, p < .06, ηp 2 = .05, revealing a tendency for LA children to present overall better memory scores than their HA counterparts. There was also a significant interaction between Memory condition, Valence, and Age, F(2, 136) = 13.44, p < .01, ηp 2 = .17. Performance on Immediate recall of emotional words increased with age, B = .03, SE = .01, p < .01, ηp 2 = .24 for positive words, B = .02, SE = .01, p < .01, ηp 2 = .11 for negative words. No such significant improvement was found on neutral words (B = .01, n.s.). In the case of Delayed recall however, the situation was reversed, performances on recalling neutral words increasing with age, B = .04, SE = .01, p < .01, ηp 2 = .20, and no such significant advantage being found for recalling emotional items. Finally, there was a significant interaction between Memory condition, Valence and Anxiety group, F(2, 136) = 3.04, p =

.05, $\eta_p^2 = .04$. Separate ANCOVAs controlling for participant age revealed that negative words were remembered less well by the HA group compared to the LA group only in the Immediate, $F(1, 68) = 4.05$, $p < .05$, $\eta_p^2 = .06$, and not in the Delayed memory condition, $F(1, 68) = .01$, n.s. Neutral words were better remembered by the LA group only in the Delayed condition, $F(1, 68) = 4.36$, $p < .05$, $\eta_p^2 = .06$. In a similar ANCOVA, we analyzed the effect of Anxiety Group (controlling for Age) on Immediate and Delayed memory intrusions generated by the interference list for the last immediate list of recall. We found a marginal effect of Memory condition, $F(1, 16\ 68) = 3.55$, $p = .06$, children displaying a tendency to produce more intrusions in the Immediate recall task ($M = 1.07$, $SE = .18$) than in the Delayed condition ($M = .40$, $SE = .06$). There was also a main effect of Valence, $F(1, 68) = 5.83$, $p < .01$, $\eta_p^2 = .08$, pairwise comparisons revealing that children produced more neutral intrusive words than both negative, mean difference = 1.23, $p < .05$, and positive words, mean difference = .95, $p < .05$. Also, children produced more negative intrusions than positive, mean difference = .28, $p < .05$. There was also an effect of interaction between Valence and Age, $F(1, 68) = 3.23$, $p < .05$, $\eta_p^2 = .05$, older children displaying a tendency to generate more neutral intrusions. In order to investigate effects of anxiety and age on performance efficiency (response times) for the Immediate verbal recall, we also conducted a univariate ANCOVA, with Anxiety group as between-group variable and Age as covariate. As expected, we found a significant effect of Age, $F(1, 68) = 12.86$, $p < .01$, $\eta_p^2 = .16$, response times decreasing with age, $B = -.30$, $SE = .08$. $p < .01$, $\eta_p^2 = .16$. No effect of Anxiety group on performance efficiency was found.

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