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Cognitive Bias in Spider Fear and Control Children: Assessment of Emotional Interference by a Card Format and a Single-Trial Format of the Stroop Task

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The aim of the study was to clarify whether fear in children is related to a distorted cognitive processing of fear-related information. In anxious children, only a few studies of this bias were performed which yielded inconsistent results. Martin, Horder, and Jones (1992. *Cognition and Emotion,* **6**(6), 479–486) found a bias for spider words in spider-fear children, using a card format of the Stroop task. However, by using a single-trial format of the Stroop task, we previously found that both anxious and control children favored the processing of threatening information (Kindt, Brosschot, & Everaerd, 1997. *Journal of Experimental Child Psychology,* **64,** 79–97). In the present study, we administered both a card format and a single-trial format of the Stroop task to spider-fear and control children. In line with our previous results, a bias for spider words was observed in spider fear but also in control children, regardless of the format used. Furthermore, the processing biases assessed by the two formats did not correlate, which suggests that they measure different mechanisms and/or that one or both mechanisms are unstable. It is speculated that certain cognitive developmental deficits in regulating emotions may be a vulnerability factor in the etiology of anxiety disorders. © 1997 Academic Press

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INTRODUCTION

In recent years, the relationship between anxiety and cognition has been extensively investigated. Although it is widely acknowledged that anxiety in adults is associated with a cognitive processing bias favoring threatening information, the mechanisms underlying this association are not well understood. An investigation of the existence of processing bias in children might shed some light on this issue. Whereas anxious adults show a processing bias for threatening information (see for a review Logan & Goetsch, 1993), studies of this bias in anxious children yielded inconsistent results (Kindt, Brosschot, & Everaerd, 1997; Martin, Horder, & Jones, 1992). Martin et al. (1992) reported a processing bias for spider-related words in nonclinical spider-fear children and not in control children. These results were in line with the above-mentioned findings for adults, and were therefore interpreted in favor of the theory that the cognitive effects of an emotion are, in general, a fundamental characteristic of that emotion. However, in two recent experiments no such differential bias was found in children (Kindt et al., 1997). Instead, in these experiments both anxious and control children appeared to favor the processing of threatening information. This finding, i.e., that this bias was not associated with anxiety in children, led us to question the generally accepted presumption that this bias forms a causal link between trait anxiety or specific fears and the development of anxiety disorders. Consequently, our findings and those of Martin et al. appear to sustain different theoretical viewpoints with respect to the role of fear-related bias in childhood in the etiology of anxiety disorders. Hence, it seems worthwhile to scrutinize the contrasting experimental results on which these viewpoints are based.

The paradigm employed in these experimental studies involved a modification of the Stroop color-naming task. In the traditional Stroop task, subjects have to name the color in which a word is printed and are slower to respond if the word is the name of a color that is not the one that is specified by the ink in which it is printed (Stroop, 1935). This delay occurs despite instructions to ignore the word, and even extensive practice fails to eliminate this phenomenon (Stroop, 1935; Jensen & Rohwer, 1966). In the modified Stroop task, subjects are presented with words of different emotional valence, written in various ink colors, and are required to name the ink color while disregarding the word content. This content will interfere with their performance on the color-naming task to the extent that subjects have difficulty in ignoring the emotional word content. This interference results in increased response latencies. Such Stroop interference implies differential processing of emotional stimuli.

Two possible explanations are given for the inconsistent results of the above-mentioned studies on processing bias in anxious children (Kindt et al., 1997; Martin et al., 1992). The first explanation relates to a difference in the type of fear of the subjects. Processing bias for threat seems to be particularly robust in subjects with circumscribed fears, like social phobics (e.g., Hope, Rapee, Heimberg, & Dombeck, 1990), spider phobics (e.g., Lavy, van den Hout, & Arntz, 1993; Watts, McKenna, Sharrock, & Trezise, 1986), and posttraumatic stress disorder (e.g., McNally, Kaspi, Riemann, & Zeitlin, 1990). However, processing bias seems to be less robust in subjects with less specific fears such as trait anxious individuals (Fox, 1994; Martin, Williams, & Clark, 1991; MacLeod & Rutherford, 1992). In contrast to trait anxious individuals, subjects with specific fears demonstrate a high degree of specificity in the characteristics of their anxiety, particularly regarding antecedent anxiety-eliciting stimuli (Logan & Goetsch, 1993). Hence, it is easier to find the appropriate stimuli which appeal to the cognitive fear-network of a specific fear than that of the trait anxious individuals. The subjects in the Martin et al. study were spider-fear children, whereas the subjects in our study were anxious children with a specific concern for medical stressors (Kindt et al., 1997). It is possible that the fear network of the latter subjects was less specific than the fear-network of the spider-fear subjects. As a consequence, the fit between the Stroop stimuli and the fear network of the subjects in our study might have been poorer than the one observed by Martin et al. (1992). On the other hand, this explanation accounts only for the absence of a differential effect between the high and low anxious subjects in our study. However, the essence of the difference between these studies is not only that we failed to find a differential processing bias, but that we did find such a bias in both anxious and control children. Hence, the divergence of the results is probably not simply due to a lack of appropriate stimuli in our study.

A second alternative explanation for the absence of differential processing bias in the two experiments of our previous study might be the following. It should be realized that our approach differed also from the work of Martin et al. (1992) with respect to the Stroop format. Martin et al. used a card format whereas we used a computerized single-trial format. In the field of cognitive psychology, the standard color-word Stroop task has been extensively used to study interference processes. Initially, the procedure in the Stroop color-word task consisted of presenting the subject with several words printed on a single card. However, cognitive psychologists introduced a more analytic methodology whereby individual stimuli could be presented and timed. Since Dalrymple-Alford and Budayr (1966) observed that this single-trial presentation also resulted in interference effects, this format of the Stroop is firmly established in cognitive interference research, primarily using computerized versions. In clinical psychological research, only recently a computerized single-trial format of the modified Stroop task was introduced, by, among others McNally, Riemann, and Kim (1990). Although these authors noticed that the computerized single-trial format of the modified Stroop may enhance the precision of the paradigm, they also emphasized that no one had yet tested the convergence of the interference yielded by the two formats. One reason to doubt whether one and the same phenomenon is measured by the two formats is that in the card format the stimuli are presented within a context of similar stimuli. In the case of a modified Stroop task, stimuli of the same emotional valence are usually presented on one card, which may enhance the emotional impact of the individual stimuli. Consequently, the card format as was used by Martin et al. (1992) may give a stronger interference effect than the single-trial format. Recently, it has indeed been demonstrated that the card format of the Stroop task revealed stronger interference than the single-trial format for trauma-related words in Vietnam combat veterans (McNally, Amir, & Lipke, 1996). The single-trial format, used in our previous experiments, might have been too insensitive to detect differences between the anxious and control children.

In the current study, we aimed to clarify whether nonclinical spider-fear children show a processing bias for spider-related information. If a processing bias for threatening information is inherent to spider fear, a bias for spider-related information would be found in spider-fear children and not in control children. Additionally, since spider phobia is more pronounced in women than in men, it was investigated whether this bias would be stronger for girls than for boys. A second aim of this study was to examine whether the format of the modified Stroop task influences the magnitude of the interference effect. A card format and a single-trial format were presented to spider-fear and control children aged 8 to 12. It was hypothesized that on both formats of the Stroop task the spider-fear children, in contrast to the control children, would show a processing bias for the spider-related words. Furthermore, it was expected that the card format would yield a stronger processing bias for the spider words than would the single-trial format in the spider-fear children. In other words, the card format would differentiate better between the spider-fear and control children. A standard color-word Stroop task was added to ensure that the original interference effects would appear in children.

METHOD

Subjects

A total of 921 children, aged 8 to 12, filled out the Spider Phobia Questionnaire (SPQ) for children. The parents had given permission for the cooperation of their child in the study. The SPQ for children was constructed for the experiment and is an adaptation of the SPQ for adults (Klorman, Weerts, Hastings, Melamed, & Lang, 1974). It consists of 10 statements of self-reported fear that have to be answered with ''true'' or ''false.'' The two questions on which Martin et al. (1992) had based their selection were also used (''Would you pick up spiders?'' ''Do you like spiders?''). The SPQ for children was internally consistent (Kuder-Richardson Formula 20 was .78). The SPQ for children was quite similar to the recently validated SPQ-C (Kindt, Brosschot, & Muris, 1996).

The children were assigned to the spider-fear group if (i) they answered both questions in the Martin et al. study (1992) negatively and if (ii) their sum score on the SPQ for children was above the 90th percentile. The control group consisted of children who (i) answered positively on the Martin et al. questions and who (ii) scored below the 10th percentile sum score of the SPQ for children. Spider fear differed significantly between the age groups and sex. In order to get an equal distribution of age and sex in the spider-fear and control groups, percentile scores were calculated separately for each age and sex. We restricted the study to children born in the Netherlands. At least one of their parents was also born in the Netherlands, in order to ensure that the words that we presented would be understood correctly.

Due to logistical problems at school or illness, 43 subjects dropped out before testing. Finally, a total of 145 children participated in the experiment, consisting of 72 spider-fear subjects (39 girls and 33 boys) and 73 control subjects (35 girls and 38 boys). Additional tests were administered to assure whether the subjects had sufficient general reading abilities and whether anyone suffered from color blindness.

Materials

Two formats of the Stroop task were administered to the subjects: a Card format and a Single-Trial format. Both formats consisted of Standard Stroop stimuli and Spider Stroop stimuli. The word sets in the Standard color-word Stroop were: (i) *incongruent color words* (red, blue, yellow, and green) and (ii) *nonwords* (loav, tmelw, ernif, muga). The word sets in the Spider Stroop were: (iii) *spider words* (spider, web, hairy, legs, crawl) and (iv) *control words* (sparrow, nest, feather, flying, bird). Spider words and control words were matched on word length and number of syllables. The control words differed from those in the Martin et al. (1992) study that used insect words. However, we considered these insect words as not being appropriate for control words. First, the English word ''ladybird'' is too long in Dutch (17 characters) to present in the Stroop task. Second, one of the words was ''colors,'' which may be very confusing in a task in which the target stimulus is a color. Therefore, we chose another category of animals as control words.

Each word set consisted of 20 stimuli. The words of the Spider Stroop were presented four times in one of the four colors: red, blue, yellow, and green. In the Standard Stroop, incongruent color words were never presented in ink of the same color. In order to obtain the same number of stimuli in the Standard Stroop as in the Spider Stroop, every color word was presented two extra times in one of the four colors and every nonword was presented one extra time in one of the four colors. In sum, both Stroop formats consisted of 80 stimulus words.

The stimuli were presented in four blocks, each block consisting of one of the four word sets. There were 24 orders of presentation of the blocks. The order of presentation within each word set was a fixed random order. Two fixed random orders of each word set were constructed. The only restrictions were that neither a word nor a color appeared more than twice in succession. Overall, there were 48 different orders of presentation of the stimuli. The subjects were randomly assigned to one of the 48 different orders of presentation, which were equally divided within one group and matched across the groups. This resulted in 35 spider-fear subjects and 36 control subjects, who were first given a Card format test, and 37 spider-fear subjects and 37 control subjects, who were first given a Single-Trial format. In the two test sessions, the subjects were presented with a different order of presentation. Words appeared in 24 pt Times characters.

Apparatus

The Stroop words were presented to the subject via an Apple Macintosh LC-II with a color monitor. In the Card format, stimuli were presented on the screen in four rows of five words. On the presentation of each word set, a fixation arrow appeared on the screen indicating where the subject should start in naming the color of each word. As soon as the word set appeared on the screen subjects started naming the colors of the words. Timing began with the presentation of the word set on the screen and stopped with the last color name to be said aloud. Response time in seconds was kept with the computer keyboard by the experimenter who was present throughout the procedure.

In the Single-Trial format, color-naming responses were detected by a voice key connected to the computer. Before the task a voice test was applied to adjust the microphone to the individual average voice level. The response times were recorded with millisecond accuracy. The presentation software recorded response latencies per word, operationally defined as the interval between stimulus word presentation and the detection of the vocal response. Errors were marked with the use of the computer keyboard, operated by the experimenter. Errors were marked when the subjects said the wrong word or in the case an utterance stopped the computer timing. Errors were registered by negative reaction times. The words appeared in the center of the computer screen. On each color-naming trial, a little fixation dot appeared at the center of the screen 1500 ms before word onset. The word was displayed until the subject reacted, with a time-out of 3000 ms. If there was no record of a response latency within 3000 ms, the trial was considered as missing and an error was registered.

Procedure

Testing was conducted in three sessions which took place at school. During the first session, subjects filled in the Spider Questionnaire for children. In the second session, the subjects were administered one of the two formats of the Stroop task: the Single-Trial format or the Card format. One week later, the subject was given the remaining Stroop format test. The subjects were tested individually. The experimenter was blind with respect to the group to which the subjects were assigned. A reading-ability test was administered to check whether the subjects had reading difficulties. A sheet with ten difficult words was presented and subjects were asked to read them aloud. For the Stroop task, subjects were instructed to name aloud as fast as possible the color of the ink in which each word or nonword was written, while ignoring the meaning of the word. The task started with a color-blindness test combined with a voice-level test, in which subjects were asked to name the color of squares which were presented in the middle of the screen. The Stroop task started with 20 practice stimuli consisting of neutral words.

Statistical Analyses

Standard Stroop data and Spider Stroop data were analyzed with a four-way analysis of variance (ANOVA) for repeated measures. There were three between-subjects factors: group, sex, and order of presentation (Single-Trial format—Card format versus Card format—Single-Trial format) and one within-subjects factor. The within-subjects factor was word set (incongruent color words versus nonwords in the analysis of the Standard Stroop, and spider words versus control words in the analysis of the Spider Stroop).

In order to compare the two formats, normalized difference scores were calculated. Analyses of variance were performed with Group as a between-subjects factor to test the prediction that the Card format would yield a stronger processing bias for the spider words than the Single-Trial format in the spider-fear children. Additionally, correlations were calculated to compare the two tests.

RESULTS

Spider Fear

Mean scores on the SPQ are presented in Table 1. A significant main effect of age was found, $F(4,125) = 3.1$, $p < .05$. Fisher's post hoc analysis revealed that the mean SPQ score of the 10-year-olds was significantly lower than the means of the other age groups, which were not significantly different from each other. The main effects of group and sex were significant, $F(1,125) = 1551$, $p < .0001$, respectively, $F(1,125) = 42.8$, $p < .0001$; but the interaction between group and sex was also significant, $F(1,125) = 14.2$, $p < .001$. The mean SPQ scores were higher for spider-fear than control children of both sexes, and although the difference was somewhat larger for girls than for boys (mean difference = 7.9 and 6.4, respectively), follow-up *t*-tests indicated that it was significant for both sexes, girls $t(72) = -42.3$, $p < .0001$, boys $t(69) = -20.1$, $p < .0001$. Also, the mean was higher for girls than for boys in both groups, and although the sex difference was larger in the phobic group than in the control group (mean difference = 2.0 and 0.5, respectively), follow-up *t*-tests showed that it was significant in both groups, spider-fear group $t(70) = -5.8$, $p < .0001$, control group $t(71) = -4.5$, $p < .0001$.

TABLE 1

Means and Standard Deviations for the SPQ Scores, Color-Naming Latencies in Seconds for the Card Format, and Color-Naming Latencies in Milliseconds for the Single-Trial Format

	Group			
	Control		Spider fear	
	M	*SD*	*M*	*SD*
SPQ for children	0.3	0.6	7.5	1.8
Boys	0.0	0.0	3.8	2.0
Girls	0.5	0.7	8.4	0.9
Card format				
Nonwords	21.8	5.7	22.7	6.3
Color words	30.3	9.1	31.6	9.2
Control words	22.3	6.0	23.4	6.7
Spider words	24.6	8.3	25.1	7.1
Single-Trial format				
Nonwords	774	157	826	176
Color words	907	197	960	228
Control words	803	165	851	184
Spider words	837	190	870	186

Note. SPQ: $N = 35$ (Control Girls), $N = 39$ (Spider-Fear Girls), $N = 38$ (Control Boys) and $N = 33$ (Spider-Fear Boys). Card format: $N = 72$ (Control) and $N = 71$ (Spider Fear) for the Standard Stroop and $N = 70$ (Control) and $N = 68$ (Spider Fear) for the Spider Stroop. Single-Trial format: $N = 72$ (Control) and $N = 69$ (Spider Fear) for the Standard Stroop and the Spider Stroop.

Standard Stroop

Standard Stroop data were analyzed in order to check whether the Stroop task yielded interference effects in general. The only significant effect for the Card format was a main effect of Word Set, $F(1,135) = 294.5$, $p < .001$, with mean response times substantially longer for the incongruent color words ($M = 30.9$ s, $SD = 9.1$) than for the nonwords ($M = 22.3$ s, $SD = 6.0$). This interference effect was not significantly different on the 5% level in the spider-fear and control groups; the largest F involving group and word set was for the Group by Order of Presentation by Word Set interaction, $F(1,135) = 3.2$, $p > .07$.

Analysis of the Single-Trial format yielded significant Stroop interference but indicated that it was larger when this format was given in the first testing session than when it was given in the second one. The main effects of Word Set and Order of Presentation and the interaction between Word Set and Order of Presentation were significant, $F(1,133) = 146$, $p < .001$, $F(1,133) = 4.2$, $p < .05$, $F(1,133) = 9.4$, $p < .01$. Follow-up tests indicated a significantly higher mean for the color words than for the nonwords in both testing sessions, Single-Trial format in the first session $t(71) = 11.0$, $p < .0001$, Single-Trial format in the second session $t(68) = 6.4$, $p < .0001$. The interference effect was not significantly different on the 5% level in the spider-fear and control groups; the largest F involving group and word set was for the Group by Sex by Word Set interaction, $F(1,133) = 2.9$, $p > .09$.

Spider Stroop

Table 1 represents mean reaction times in seconds for the Card format of the Stroop task. An analysis of the Spider Stroop data showed that all subjects needed more time to name the color of the spider words ($M = 24.9$ s, $SD = 7.7$) than of the control words ($M = 22.8$ s, $SD = 6.4$). This difference was highly significant, $F(1,130) = 21.2$, $p < .001$. There were no main effects of group, sex, or order of presentation. Moreover, no two-way interaction effect between group and word set was shown, indicating that spider-fear children did not differ from control children in their cognitive biases for spider-related stimuli. There were no further interaction effects.

Mean color-naming latencies in milliseconds for the Single-Trial format of the Stroop task are presented in Table 1. Outlier latencies below 300 ms were eliminated from the analyses and outliers above 3000 ms were not recorded by the computer. Reaction times below the 300 ms and above the 3000 ms could not have been appropriate reactions to the stimulus; it indicates either a guess or distraction. Mean error percentage was low ($M = 2.9\%$; $SD = 2.9\%$). Analysis of the error percentages produced a main effect of order of presentation, $F(1,137) = 9.9$, $p < .01$, with mean error percentage higher when the Single-Trial format was presented first ($M = 3.6\%$; $SD = 3.3\%$) than when it was presented last ($M = 2.1\%$; $SD = 2.4\%$). There was also an interaction effect between group and sex, $F(1,137) = 5.0$, $p < .05$, with the control girls and the spider-fear boys showing somewhat more errors than the other two groups. Overall, error rates did not correlate with the interference scores and were not taken into consideration in the remainder of the analyses.

An analysis of the Spider Stroop data showed again a significant difference on word set, $F(1,133) = 7.4$, $p < .01$. Thus the color-naming performance of all subjects was more disrupted on spider words ($M = 853$ ms, $SD = 188$) than on control words ($M = 826$ ms, $SD = 175$). No other main effects or interaction effects were observed. Hence, on the Single-Trial format too, spider-fear children did not diverge from the control children in their processing of spider-related information.

Additional Data Analyses

Children of different age groups differed in their degree of spider fear as assessed by the SPQ for children. Therefore, additional analyses of variance were carried out to examine the possibility that age exerted a differential effect on the emotional bias between the spider-fear and control groups. Sex was included in order to investigate whether a possible age effect was related

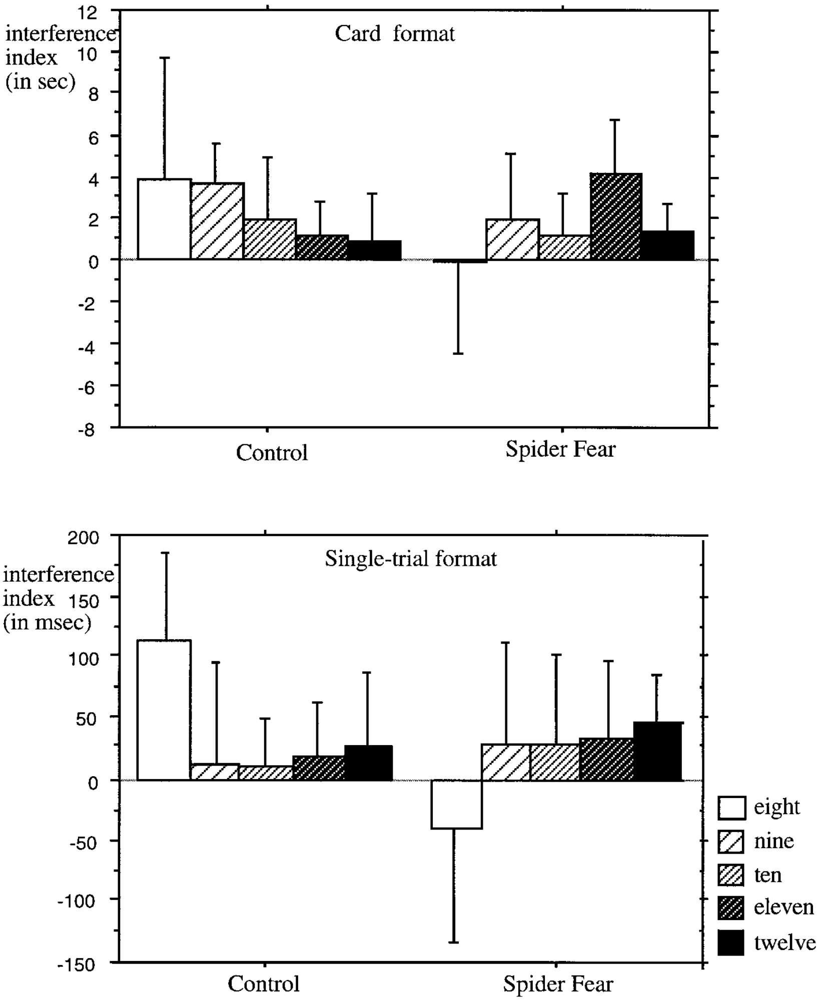

FIG. 1. Mean spider interference scores ($RT_{spider} - RT_{control}$) on the Card format and the Single-Trial format for the spider-fear and control group split by age.

to sex. Analysis of variance of the Card format data, with three between-subjects factors (group, age, and sex) and one within-subjects factor (word set), showed no significant main effects or interaction effects. Although the pattern of differences of spider interference scores ($RT_{spider} - RT_{control}$) between the age groups is evidently not the same in the spider-fear and control groups (see Fig. 1), the interaction effect between group and age was not significant, $F(4,118) = 1.7$, $p = .15$. Spider interference scores of the Single-Trial format were analyzed in the same way as the Card format data and are presented in Fig. 1. The only significant effect was the interaction between group and age, $F(4,121) = 2.7$, $p < .05$. The pattern of differences of spider interference scores between the age groups is clearly not the same in the spider-fear and control groups, as can be seen in Fig. 1. It seems that the spider interference in the spider-fear group increases with age, as opposed to interference in the control group.

Comparison of the Two Stroop Formats

In both the Card format and the Single-Trial format, main effects of word set were revealed in the Standard Stroop and in the Spider Stroop. Therefore, the two formats can be compared on these effects. In the Card format, errors cannot be removed from the total reaction time. In order to minimize the influence of extreme reaction times for one word set, normalized interference indices were calculated as follows:

$$\text{Normalized Spider Interference Index} = \frac{RT_{spider} - RT_{control}}{(RT_{color} + RT_{nonwords} + RT_{spider} + RT_{control})}.$$

Comparison of the normalized color interference indices of the two formats disclosed a significant effect of format, $F(1,132) = 9.5$, $p < .01$, with more color interference produced by the Card format ($M = .34$, $SD = .20$) than by the Single-Trial format ($M = .26$, $SD = .21$). Comparison of the normalized spider interference indices also showed stronger spider interference by the Card format ($M = .08$, $SD = .18$) than by the Single-Trial format ($M = .03$, $SD = .13$), $F(1,132) = 6.4$, $p < .05$. There were no effects of Group. Thus, in general, the Card format appeared to cause more interference than the Single-Trial format.

Additional analyses were carried out in order to investigate whether interference in the Card format and the Single-Trial format are actually the same phenomenon. Pearson p-m correlation coefficients were unexpectedly low for the two color indices ($RT_{color} - RT_{nonwords}$), $r(139) = .13$, $p = .13$, and for the two spider indices ($RT_{spider} - RT_{control}$), $r(134) = .13$, $p = .13$. This indicates that there is no convergence between the two formats in assessing interference. Correlations were calculated separately for the five age groups, each of which consisted of 24 to 30 children. The results for the groups (8 to 12 years) were, respectively, $r = .17$, $r = -.08$, $r = -.05$, $r = .05$, and $r = .32$ for the two color indices and $r = .35$, $r = -.11$, $r = .04$, $r = -.27$, and $r = .49$ for the two spider indices. Although only the last of these correlations was significant ($p < .01$), it is clear that the correlations differ considerably between the age groups. This suggests that age may be at least partly responsible for the absence of convergence between the two formats in the total sample.

DISCUSSION

The results of the present study indicate that spider fear is not related to a cognitive processing bias in children. Spider-fear children did not show a stronger processing bias for spider-related information than did control children. Instead, both spider-fear and control children favored the processing of spider-related information, irrespective of the Stroop format used. Hence, the finding of Martin et al. (1992) that only spider-fear children showed a bias for spider words could not be reproduced. In contrast, the finding that all children showed a processing bias for spider-related information is consistent with our previous finding that anxious as well as control children showed a processing bias for threatening information (Kindt et al., 1997). Furthermore, all children showed a standard Stroop effect, regardless of the format of the Stroop task, which indicates that the prerequisite of administering the Stroop task to children was met. The present results, combined with those of our previous experiments, suggest that processing bias for threatening information is not associated with anxiety in children. This indicates that the processing bias for threatening information, which has been repeatedly found in anxious adults, is not necessarily inherent to anxiety in children, at least not to nonclinical anxiety. Instead, such a bias might depend on developmental capability or other factors. However, a clearly different position is taken by Martin et al. (1992) who maintain that the cognitive bias for threatening information is a fundamental characteristic of anxiety. The controversy rests upon the different outcomes of the studies, and several methodological factors may account for this divergence. In the study of Martin et al., a card format of the Stroop task was used to measure processing bias. In our previous studies, computerized single-trial formats were used, while in the present study both a card format and a single-trial format were presented to the children. There are two obvious differences between the two formats of the Stroop task. First, in the single-trial format the responses are timed by the computer with millisecond accuracy, which cannot be realized with the card format. Second, in the card format, the experimenter records the response times him- or herself. Consequently, when a card format is used to assess differential processing bias in anxious individuals, it is even more important for the experimenter to be ignorant of the group to which each individual belongs. This was not the case in the Martin et al. study. Moreover, since the differences in response times between the spider-fear and control children in their study were only seconds, the influence of the experimenter cannot be excluded.

Another methodological factor that may explain the contrasting results pertains to the possibility that the interference effect is unstable. Some discussion of the relation between the two formats may clarify this issue. An unforeseen result of the present study was the striking lack of correlation between the spider interference scores on the card format and the single-trial format. In anxiety research, use has been made of either one of these formats of the Stroop task. So far, no attempt has been made to show convergence between the emotional interference scores produced by the two formats. In the light of our results such convergence must now be sincerely questioned—at least in children. The lack of correlation in our study cannot be explained by a practice effect, since there was no effect of order of presentation on the spider Stroop interference. Two remaining explanations for the lack of correlation are that (1) the two formats measure different mechanisms and/or that (2) one or both mechanisms are unstable. The main difference between the two formats is based on the fact that the single-trial format has no context stimuli. The fact that each spider word is presented in a context of words of related content might enhance their effect. Additionally, there are more distracting stimuli in the card format than in the single-trial format. Consequently, in the card format, a considerable part of the spider interference may be due to hindrance by these context stimuli, while in the single-trial format only the hindrance of the distractor word is present. Literature on cognitive development suggests that there are age differences in the ability to ignore distracting irrelevant information (Lane & Pearson, 1982). A curvilinear relationship was found to exist between age and the disruption of irrelevant stimuli: it increases from age 7 to age 11 and then decreases substantially from age 11 to age 20. The lack of convergence between the two formats of the Stroop task may be at least partly, due to developmental differences in the cognitive ability to ignore the context stimuli in the card format. The other explanation of a lack of convergence is related to a possible instability of the interference effect. Instability of the underlying mechanism of emotional interference may be due to resource limitation, a condition which may fluctuate in time. This does not preclude emotional word effects because, on the average, spider words may still be more difficult to ignore than neutral words. The first of the two explanations, i.e., that the two formats measure different mechanisms, can not account for the divergence in results between the two studies (Kindt et al., 1997; Martin et al., 1992). While both studies used a card format, Martin et al. did find a differential processing bias whereas we did not. In contrast, an instability of emotional interference—the second explanation—may have contributed to this divergence. In addition, we cannot exclude the possibility that errors in the card format contributed to the lack of correlation. In the single-trial format, errors were excluded from analyses, whereas they cannot be excluded from the total reaction times in the card format.

The least that can be concluded on the basis of the available evidence is that anxiety-related differential processing bias for threatening information is not as robust a phenomenon in children as it is in adults and it may even be absent below a certain age. On the other hand, irrespective of their fear, all children showed a bias for spider-related information. This finding led us to speculate that, to a certain extent, anxious as well as control children lack abilities to inhibit the processing of emotionally meaningful information. First, however, an alternative explanation needs to be eliminated before this issue will be pursued.

The finding that all children showed a bias for spider words suggests that it might be a word effect that is not related to the emotional content of the words but to their readability. Stimulus word sets are usually matched on readability, operationalized in terms of familiarity or lexical frequency, word length, and number of syllables. From the standard Stroop studies it is well known that nonwords yield a significantly smaller interference effect than words. However, in the emotional Stroop task, it is unlikely that the magnitude of the differences in readability that may still exist between reasonably well-known word sets which differ in their meaning, account for bias effects related to their meaning. In two recent studies (Riemann, Amir, & Louro, 1995; Riemann & McNally, 1995), it was shown that the emotional Stroop interference was not attributable to word length and frequency of usage. In one of their studies (Riemann et al., 1995), it was shown that, irrespective of large differences in word length and lexical frequency between neutral words and emotional words, there was no differential emotional interference effect in normal control subjects, whereas this effect was present in anxious subjects. In the other study (Riemann & McNally, 1995), highly significant differences between neutral and emotional words in word length and frequency also did not yield differences in Stroop interference. There is some further evidence that emotional interference can not be accounted for by familiarity. In several studies (Lavy & van den Hout, 1993; Lavy et al., 1993; Mathews, Mogg, Kentish, & Eysenck, 1995; Mattia, Heimberg, & Hope, 1993; Mogg, Bradley, Millar, & White, 1995; Watts et al., 1986), it was shown that the processing bias for threatening information in anxious subjects was reduced after treatment. Since it is not plausible that the familiarity of the threat words is decreased after treatment—on the contrary, it will even be increased by it—emotional interference must be due to the emotional salience of the stimuli rather than to cognitive expertise (Watts, 1986). Thus, emotional Stroop interference seems not to be confounded by factors related to readability. Hence, the finding that all children show a bias for spider words is probably not due to word factors related to a difference in readability.

Instead, this general bias for spider words can be explained in terms of cognitive developmental differences between children and adults in their ability to inhibit the processing of threatening information. During development children acquire cognitive abilities to control the processing of emotional stimuli (Flavell, 1985). The finding that control children, in contrast to control adults, show a processing bias for threatening information may be due to a lack in their ability to inhibit the processing of threatening information during the Stroop task. This can be explained in terms of cognitive control processes, following the theory of MacLeod and Mathews (1991). These authors observed that anxiety is related to a processing bias only when the subject is exposed to two simultaneously presented stimuli and the subject must assign priorities to a target stimulus while inhibiting the processing of a distractor stimulus. They argued that anxiety does not lead to an increase in the availability of threatening information from memory, but instead influences the mechanisms which control the assignment of processing priorities. Thus, anxious individuals give precedence to the processing of threatening information. This processing happens at the expense of processing other information, due to the limitations on the information-processing capacity of the human cognitive system. Developmental psychologists have argued that these limitations are even more severe in children than in adults (Flavell, 1985). Thus, our finding that the control children gave just as much precedence to spider-related information as the spider-fear children may be caused by a lack of higher order cognitive mechanisms to inhibit the processing of this information.

At a first glance, it might appear unclear why spider words also yield a processing bias in children with no spider fear. However, this can be explained as follows. Although spider information is not in itself threatening, human beings very readily learn to be afraid of spiders (see Öhman, 1993). Moreover, stimuli that are more difficult to survey and movements that are difficult to predict generally evoke alertness and wariness (Frijda, 1986). Hence, as a consequence of this characteristic, spider stimuli may have the potential to yield a processing bias in all children. This may be caused by a lack of the ability to inhibit the processing of this information, which may be a normal characteristic of their stage of development. This is also in line with the view of Menzies and Clarke (1995) who argue that phobias for this kind of stimuli may best be understood as the failure of certain people to unlearn their childhood fears for them (Menzies & Clarke, 1995).

In summary, our results are consistent with our previous work (Kindt et al., 1997). They illustrate that children, irrespective of the level of their fear or anxiety, show a processing bias for potentially threatening or threatening information. This contrasts with the performance of adults, of whom the low anxious individuals do not have a processing bias for such information. Hence, these results seem to suggest that such a bias per se seems not to form a causal link between anxiety or fear and the development of anxiety disorders. Moreover, a negative association between bias and age appears to be present in the control group which is not present in the spider-fear group. This may indicate that low fear children learn to regulate the processing of threat while this learning process may fail in spider-fear individuals. Apparently, a longitudinal study is needed to delineate the exact role of cognitive developmental capabilities to inhibit threatening information in the development of anxiety disorders. In addition, it might also be worthwhile to study the psychometric qualities of the modified Stroop task in adults to clarify whether the lack of convergent validity is restricted to children.

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