

Rapid Acquisition of Emotional Information and Attentional Bias in Anxious Children

Eamon P . Fulcher
University of the West of England

Andrew Mathews
University of California at Davis, USA

Marianne Hammerl
University of Regensburg, Germany

Abstract

This study reports on the relationship between evaluative learning (EL) and attentional preference in children with varying degrees of anxiety, as measured by the Multidimensional Anxiety Scale for Children, and varying degrees of parental anxiety, as measured by scores on the Beck Anxiety Inventory. In the first experiment, 3 age groups (7-8, 10-11, and adults with mean age 26.8 years) were compared on a novel EL method, in which neutral images “morphed” over 1 s into either smiling or angry adult faces. There were no differences in EL between the age groups – each showing a strong EL effect. In 2 subsequent experiments, we examined learning and attention to stimuli following EL trials in 7- to 8-year olds. In Experiment 2, Panic/Separation Anxiety (PSA) and the mothers' BAI predicted the overall magnitude of EL. In addition, high PSA children were more likely to attend to a neutral stimulus previously paired with a negative stimulus than were low PSA children. In Experiment 3, only PSA was positively associated with the magnitude of EL. In the attention trials, high PSA children had longer fixation times on frowning faces than did low PSA children. These results indicate that associations between learning, attention, and emotional information are influenced by separation anxiety and maternal anxiety.

Keywords: Information processing; Perception of threat; Anxiety; Children; Conditioning

1. Introduction

A normal response to a situation that involves some form of extreme threat is to focus one's attention on the source of the threat and to monitor its development. However, when a threat is only mild or moderate, individuals with an anxiety disorder and often people who score highly on an anxiety measure demonstrate preferential processing of the threat (MacLeod & Mathews, 1988; Mathews & MacLeod, 1994). Cognitive bias, which is the tendency to preferentially attend to threatening stimuli or to perceive ambiguous stimuli in threatening ways, has been studied and observed using several different methods.

Firstly, a threatening item is more likely to capture attention when presented alongside a

neutral or innocuous item (MacLeod, Mathews, & Tata, 1986). Two items are presented at two different locations on a monitor, and one of them is replaced by a probe or target. The task is to press a button as soon as the target appears. The logic is that the response time to the target should be speeded when the target appears in the same location as the one being attended to, and slowed when the target appears in the other location. The findings of a number of studies suggest that attentional bias occurs without awareness or intent (Fox, 1996; MacLeod & Rutherford, 1992).

Secondly, a threatening item can interfere with an ongoing task. In a version of the Stroop task, emotion words are printed in different colours with the task to name each colour. Words related to threat (e.g., collapse, failure, and so on) tend to slow anxious individuals on this task, and this may be because for them threatening material is unavoidable (Williams, Mathews, & MacLeod, 1996).

Thirdly, a threatening item once noticed can hold attention for longer than a non-threatening item. When a target is presented immediately after the presentation of an item in another region of a visual display, anxious individuals are slower to disengage from a threatening item than from a non-threatening item (Yiend & Mathews, 2001).

Fourthly, a sentence or word that has more than one meaning is more likely to be interpreted negatively by anxious than non-anxious individuals. For example, the homophone *stroke* can have two interpretations: *disease* or *caress*. Anxious individuals are likely to access the more threatening meaning of ambiguous words than non-anxious individuals (Mathews, Richards, & Eysenck, 1989; Richards & French, 1992). It has been suggested that the cognitive processes that promote a negative interpretation of ambiguous material are the same that drive attention towards threat (Mathews & Mackintosh, 1998).

The association between cognitive bias and anxiety may arise because moderate to high states of anxiety can promote a particular cognitive style. For example, anxiety levels can predict the presence of an attentional bias: it is commonly present in clinically anxious populations but disappears after successful treatment (e.g., Mathews, Mogg, Kentish, & Eysenck, 1995). Therapy can have effects even on unconscious attentional bias (Lavy, Van Den Hout, & Arntz, 1993). However, in addition to the possibility that anxiety induces bias, cognitive bias may be one of many causal agents in the development of chronic anxiety. If threatening information receives processing priority it may induce anxiety, and a habitual cognitive style of attending to threat over prolonged periods may exacerbate, maintain, or initiate anxiety states.

A possible causal hypothesis is that in early development cognitive bias is acquired either through some form of learning, either as a result of traumatic or mild but repeated fearful experiences. Bias might also be acquired indirectly by observing others, especially mothers and other care givers, attending to threat or interpreting innocuous stimuli as threatening. Another route through which it may be acquired is via verbal transmission of information about potential dangers and sources of threat. Certain situations, people, events, and other stimuli may thus become labelled as potentially threatening, even in the

absence of confirmatory experience. The range of stimuli labelled in this way may increase and the threshold for the detection of threat may become lowered. Furthermore, with repeated practice selective attention to threat may become automatised, such that it is done effortlessly, rapidly, without voluntary intention or control. If so, a likely effect is an increase in the regularity of the experience of fear and anxiety, more intense experiences of anxiety, the adoption of a number of coping strategies, such as avoidance of potential sources of threat, and an increase in the range of the behavioural symptoms of anxiety (Mathews & MacLeod, 1994) .

Although there is considerable evidence of a relationship between anxiety and cognitive bias, only a handful of studies can be considered to have addressed the causal hypothesis. In the absence of a longitudinal study in which anxiety and cognitive bias are measured in both children and parents from childhood into adulthood, we have only indirect methods at our disposal. However, there is at least some evidence for several aspects of the version of the causal hypothesis outlined above.

Firstly, there is convincing evidence that parental fears can be transmitted to their children. Parental reaction to a traumatic event, for example, can influence the development of post traumatic stress disorder (PTSD) in their children (Foa, 2000). Furthermore, Muris, Steerneman, Merckelbach, and Meesters (1996) found that children of mothers who tend to verbalise their fears regularly had an elevated number of fears of specific situations and stimuli, and that these fears were related to the mother's fears. Other research suggests that the responses of a caregiver can influence a child's fear reaction (Klennert, Campos, Sorce, Emde, & Sredja, 1983). In a study by Field, Argyris, and Knowles (2001) it was found that vicarious learning in children, in the form of negative information given by adults about a fictitious character, can lead to increased fear beliefs.

Although these studies are not evidence that attentional bias is transmitted from parent to child, they are consistent with the notion that fears and anxiety can be acquired vicariously in children. Other studies have shown that vicarious fear conditioning (by observing others experiencing a mild shock or by being informed about shock contingencies) can be as effective as Pavlovian conditioning in which shocks are actually delivered (Olsson & Phelps, 2004) and that a mother's fearful facial-expression can act as strong unconditioned stimuli for their young children (Gerull & Rapee, 2002). Taken together, the studies reported here are consistent with one aspect of the causal hypothesis, which is that anxiety can be transmitted from parent to child through verbalised negative information.

A second important line of research is to examine cognitive bias in children with anxious parents. Moradi, Neshat-Doost, Teghavi, Yule, and Dalgleish (1999) examined attentional bias in children of mothers with PTSD. They found that in comparison to a control group, children of mothers with PTSD showed greater attentional interference from threat-related words than from emotionally neutral words. Relating this finding to the causal hypothesis, the study is consistent with the view that attentional bias is one consequence of the emotional background in the family and that the bias may predate

manifest anxiety. However, since anxiety levels were not measured in the children, the study does not rule out the possibility that high levels of anxiety were already present in the children of mothers with PTSD. In a recent study of our own, we found an association between attentional bias in children with anxiety in their mothers (Fulcher, Mathews, Emler, Catherwood, & Hammerl, 2006). This association was independent of the child's level of anxiety. This could be interpreted as evidence that attentional bias (vigilance) is present before the child acquires a measurable level of anxiety, which is entirely consistent with the causal hypothesis.

A third line of research is to test the most important element of the causal hypothesis, which is that attentional bias promotes a direct increase in anxiety. Mathews and Mackintosh (2000) and Mathews & MacLeod (2002) demonstrated that interpretations of emotionally ambiguous words can be biased in either a positive or negative direction by brief training methods. Furthermore, congruent changes in anxiety do occur when the induced bias is subsequently deployed in processing mildly stressful events. Hence emotional processing styles may play a causal role in producing emotional changes. These studies support the notion of a causal relationship between attentional bias and anxiety, but clearly more evidence is needed.

In terms of how the perception of threat may spread to new stimuli, we recently identified a potential mechanism for this, namely evaluative learning. In this form of learning, a neutral stimulus when paired with a stimulus of positive valence comes to be valued more positively than before, and a neutral stimulus that is paired with a stimulus of negative valence comes to be valued more negatively (Baeyens, Eelen, & Van den Berg, 1990; Fulcher & Cocks, 1997; Hammerl & Grabitz, 1996; Levey & Martin, 1975). It is unclear whether this change in the affective significance of the stimulus is due to the fact that it predicts the occurrence of another affective stimulus or whether the stimulus has somehow itself become imbued with valence (Fulcher, 2001). A large number of studies have shown that the change in valence brought about through evaluative learning occurs without awareness of the stimulus contingencies, that is the effect is present when participants are unable to recall, recognise, or even perceive the affective stimulus that was paired with a particular neutral stimulus (De Houwer, Thomas, & Baeyens, 2001; Fulcher & Hammerl, 2001; Hammerl & Fulcher, 2005). In a recent study of ours, stimuli that acquired negative valence (and hence some threat value) through evaluative learning, were more likely to capture attention in anxious but not less anxious individuals (Fulcher, Mathews, Mackintosh, & Law, 2001; Mackintosh and Mathews, 2003). These studies demonstrate that threat value can be spread onto a previously neutral stimulus by a contagion it has become associated with. Furthermore, they show that stimuli with acquired threat value can attract attention in anxious individuals. Evaluative learning may therefore be an important element of the causal hypothesis since it shows how perceived threat value can spread and thereby extend the range of stimuli that are able to capture attention. If so, the ease with which evaluative learning occurs and/or the extent to which such learning leads to attentional bias effects may be characteristic of those who are vulnerable to develop anxiety states (Fulcher, et al., 2001).

In the present study, we therefore attempted to assess the ease of evaluative learning and

any consequent attentional bias to newly emotionalised stimuli, in anxious children. We are unaware of any previous study that had done this. The first aim was to compare the magnitude of evaluative learning in three age groups to assess any developmental differences. We then observed attentional preference following evaluative learning to ascertain whether stimuli imbued with valence would indeed capture attention in children with anxiety or with anxious parents. Next, we attempted to find out whether anxious children or those from anxious parents showed any difficulty in disengaging from negative images and from images with imbued valence.

The anxiety measure used was the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). This was chosen because it measures a number of dimensions, such as physical symptoms, harm avoidance, social anxiety, and panic/separation anxiety (SA). The latter may be particularly important since a number of theories have postulated a key role for separation anxiety in adult psychopathology. For example, SA in children has been thought to (1) predispose to a variety of anxiety disorders (Tyrer, 1985), (2) be a precursor to dependent personality disorder in adults, and (3) be a predictor of an adult form of SA (Silove & Manicavasagar, 2001).

The causal hypothesis predicts an association between parental (and especially maternal) anxiety and attentional bias. It also predicts that this association will exist in the absence of child anxiety, although its presence does not falsify the hypothesis since anxiety may already be present. The causal hypothesis also predicts that child anxiety will be associated with an evaluative learning bias, manifested as a rapid learning of negative associations (since negative emotional stimuli may be perceived as more salient than positive emotional stimuli in anxious children).

2. EXPERIMENT 1

The evaluative learning paradigm has been almost exclusively used on adult samples and these authors are aware of only a single study, Field (2006), that has adapted the method for children. In that study, neutral cartoon characters were paired with liked food (e.g., ice-cream) and disliked food (e.g., Brussel sprouts). Characters paired with liked food became more liked than characters paired with disliked food. In this experiment we attempted to compare different age groups on an evaluative learning task. We also wished to pilot a new method for presenting the pictures, which involves morphing a neutral image into an emotional image. A “morph” is an animation that transforms one picture to another and in a smooth manner. The question is whether a neutral picture that is transformed into a smiling face will be more liked than a neutral picture that is transformed into a frowning face.

2.1 Method

2.1.1 Participants

Participants were 15 children in Year 3 Primary of ages 7-8 years, 15 children in Year 5 primary of ages 10-11, and 15 adults (mean age 26.8 years) recruited from a university campus. The children were recruited from a local urban school in the UK . Recruitment was via a random sampling procedure, where each child had an equal chance of being selected once they had opted in. Signed permission was obtained from the caregivers as well as from the participating children, after a brief outline of the procedure had been given. The experimental procedure was approved by the Ethics Committee at Worcester University and The Worcestershire NHS Ethics Committee.

2.1.2 Materials

The stimuli consisted of 8 separate morphs, which were developed as MPEG files, created from 16 pictures (8 neutral pictures, 4 of smiling faces and 4 of frowning faces). Each morph consisted of a Japanese ideograph (representing a neutral picture) transformed over 1 s into either a smiling or frowning human face. For the purposes of counter balancing, two morphs were created for each ideograph: one that transformed into a smiling face and one that transformed into a frowning face. Two sets of morphs were created, with each picture appearing only once in each set. Thus, half of the neutral stimuli morphed into one of the smiling faces in set 1 and into one of the frowning faces in set 2. Similarly, the other half of neutral stimuli morphed into one of the frowning faces in set 1 but morphed into one of the smiling faces in set 2. Participants were then divided into two groups on a random basis with half being shown set 1 and the other half shown set 2.

The eight ideographs were selected from a set that was hand drawn by a Japanese-speaking colleague. The affective pictures consisted of eight photographs of faces taken from four adults (each model was photographed twice: once when asked to pose with an angry expression and once when asked to pose with a smile). These photographs were used in a previous unpublished study and were selected from a large sample on the basis of the threat rating of the angry expression and the pleasantness rating of the smiling expression by a panel of raters. Those pairs that provided the highest ratings for both expressions were selected. The morphing transformations were created by identifying a set of 12 dots on each ideograph and 12 corresponding dots on the target image. The purpose of the dots is to match up key features in each picture and to instruct the program how the first picture should morph into the second picture, so that the transformation is smooth. The morphing program then rendered the images to create a movie file that was subsequently converted into an MPEG file. Each movie file was presented on a computer monitor controlled by a script written for the Inquisit software. Pictures measured 12 cm x 9 cm . Each participant was exposed to eight morphs over two trials.

2.1.3 Procedure

The experiment consisted of three phases: pre-trial rating, learning trials, post-trial rating, and recall. In the pre- and post-trial rating phases, which were identical, the (static)

ideographs were presented separately and the task was to rate each one on a scale ranging from 0 to 100 with intervals of 10 (11 anchor points in all). The participants were told that the more they liked the picture, the higher the number they should assign, and the less they liked a picture the lower the number they should assign. In the learning trials, the order of the morphs was randomised. A trial began with a fixation point (a yellow cross in the centre of the screen) for 3 s that was replaced by a blank screen for 2 s. The morph then appeared for 1 s and there was an 8 s pause between trials. Thus, each trial lasted 14 s. The morphs were shown twice (in two blocks) and hence there were 16 trials in all. This is quite an unusually low number of trials for an evaluative learning experiment (8 pairs each shown twice), and we did this for two reasons: (1) The planned Experiments 2 and 3 involved additional phases and we were limited in how long we could test each child, and (2) the morphs were quite dramatic (in the sense that the movement enhanced the emotional tone of the appearing face); and hence we suspected that evaluative learning would occur rapidly.

In the recall phase, the ideographs were presented individually and the participant had to state whether the ideograph morphed into a happy/smiling face or an angry/frowning face. Including time for providing instructions, testing lasted about 15 minutes for each participant.

2.2 Results

For each participant, the mean rating of the ideographs was calculated. This was done separately for the pre-trial and the post-trial rating phases and according to the valence of the paired image. The data was then entered into a Valence (paired with smiling or frowning) x Time (pre- or post-learning trial) x Age group (7-8, 10-11, or adult) mixed ANOVA. The predicted interaction of valence and time was statistically significant, $F(1, 42) = 9.849, p < .005$. There was no interaction between valence, time, and age group, $F(2, 42) = 2.296, p > .05$. The means were as predicted for the participants as a whole and indicate that ideographs paired with smiling faces showed an increase in liking after the learning phase (M pre-learning = 43.7 and M post-learning = 47.5), whereas ideographs paired with frowning faces showed a decrease in liking (M pre-learning = 45.6 and M post-learning = 42.5). There were no other main effects or interactions.

In terms of the ability to recall the ideograph-face pairs the mean recall for each age group was calculated and entered into an age group one-way ANOVA, which was not statistically significant. Each age group recalled about 50% of the pairs. In order to examine the role of contingency awareness further, a correlation was carried out between an overall evaluative learning index and recall score for each participant. The Evaluative Learning Index (ELI) was calculated by:

$$\text{Evaluative Learning Index} = (V + 2 - V + 1) - (V - 2 - V - 1)$$

where V refers to the mean rating of an ideograph, + or - refers to whether the ideograph morphed into smiling or frowning face, respectively; 1 refers to pre-trial rating, and 2 to post-trial rating. The higher the ELI, the stronger the learning effect. An ELI of 0 implies

no learning effect at all, and a negative ELI implies an effect orthogonal to that predicted. The overall ELI was calculated to be +6.9. The correlation between ELI and recall score was not statistically significant, $r(45) = -.067, p > .05$. Further, recall of positive associations did not correlate with a positive ELI (calculated by $V + 2 - V + 1$; and calculated to be +3.8 overall), $r(45) = 0.028, p > .05$, and recall of negative associations did not correlate with a negative ELI (calculated by $V - 2 - V - 1$; and calculated to be +3.1 overall), $r(45) = .061, p > .05$. A further analysis consisted of splitting participants into two groups by a median split of their recall scores and then comparing the overall ELI of the two groups. This analysis revealed no statistically significant difference between the two recall groups, $t(43) = 0.288, p > .05$.

2.3 Discussion

The most important finding is that the morphing of a neutral picture into a valenced one is a valid and novel method to induce evaluative learning. What is remarkable about this method is that only two presentations of each morph were sufficient for learning to occur and this may be due to the high potency of the morphed images. The second finding is that all age groups show evaluative learning effects. This is an important finding for the subsequent experiments. A third finding is that evaluative learning appears to be independent of an ability to recall the pairs, and this adds to the already weighty body of evidence that evaluative learning is not dependent on contingency awareness.

3. EXPERIMENT 2

One aim of the next experiment was to attempt to test the prediction that anxious children and/or children with anxious parents would show a bias in evaluative learning. In other words, we asked whether (1) the mother's or father's anxiety would predict the extent of evaluative learning in their children, (2) whether any of the measures of child anxiety would predict the strength of evaluative learning, or (3) whether the child's and parent's anxiety levels would interact with the strength of evaluative learning. A second aim was to examine the role of attention to previously neutral stimuli, imbued with valence following evaluative learning, and to determine whether vulnerable children show an attentional bias not only to the unpleasant images, but also to the images imbued with valence. The same morphing procedure was used as in Experiment 1 (with the same stimuli) and the ideographs were also evaluated before and after learning trials. One difference in the evaluative learning procedure between this experiment and the previous one was that we noticed that some of the lower aged children had difficulty in using the rating scale and required regular reminding of how to use the scale. For this reason, we employed a ranking technique used previously in Field, Argyris, and Knowles, (2001), so participants had merely to express preference rather than identify some point on a scale.

3.2 Method

3.2.1 Participants

Participants were 44 children (22 boys and 22 girls) in Year 3 Primary of ages 7-8 years

recruited from 10 local schools, including 1 independent school (urban), 4 urban state schools, and 5 rural state schools. Signed permission to participate was obtained from the main caregiver as well as from the child. A brief outline of the main task and the type of materials that would be shown was presented before requesting permission. The experimental procedure was approved by the Ethics Committee at University of Worcester and The Worcestershire NHS Ethics Committee. Recruitment from each school was via a random sampling procedure, where each child who had opted in had an equal chance of being selected (with the constraint that we required equal numbers of boys and girls). All children showed willingness to participate. Donations were made to each participating school, and the amount was based on the number of children tested. Each child was given a small toy for their participation.

Materials

3.2.2 Beck Anxiety Inventory (BAI). The BAI (Beck, Epstein, Brown, & Steer, 1988) questionnaire was distributed to all parents of selected children at participating schools. Parents or guardians (both male and female carers where possible) responded to 21 items. Each item is descriptive of subjective, somatic or pain related symptoms of anxiety. Each question asks how much each of the symptoms had bothered them in the past week.

3.2.3 Multidimensional Anxiety Scale for Children (MASC). This scale has been developed for and tested on children between the ages 8 to 16 (March, et al. 1997). It is a 39-item questionnaire and factor analysis reveals that it has four sub-scales that measure Physical Symptoms (tension, restlessness, and somatic/autonomic symptoms) , Harm Avoidance (perfectionism and anxious coping) , Social Anxiety (humiliation/rejection and public performance fears) , and Panic/Separation Anxiety (PSA), and also provides a total anxiety score (sum of the sub-scales). It has been shown that girls score significantly higher on all factors than boys; that parent-child agreement is moderate, but highest for easily observable symptoms (March et al., 1997), and that parent-teacher agreement is good (Fulcher et al., 2006). This questionnaire was completed by parents of the children selected to participate.

3.2.4 Stimuli. In this experiment the same stimuli as in Experiment 1 were used.

3.2.5 Eye-tracker. An ASL eye-tracker system was used in this experiment, consisting of an infra-red camera, which was mounted next to the TFT monitor. The system was controlled by “e-5Win” software, which manipulated the camera to capture the participant's pupil and corneal reflex. A monitoring screen displayed the participant's eye. The camera operates remotely from the participant and no headgear is required. The software records the x-y coordinates of the eye fixation once every millisecond and stores this in a fixation file. Additional software written by the first author controlled the presentation of all stimuli and this software also signalled unique codes to the fixation file for all stimulus onset and offset times, making it possible to marry eye fixations with the particular stimulus being presented. Further software, also written by the first author, was used to compute first fixations on each of the trials. This software was tested and shown to be accurate when compared with a sample of computations carried out manually. The

system was configured for each participant at the start of the experiment, although only eye movements during the attentional trials were recorded.

3.2.6 Procedure

The same procedure was used as in Experiment 1, with the following exceptions: (1) a preference procedure was used to measure liking/disliking, (2) there was no test of contingency awareness, and (3) there was an additional final phase consisting of a number of attentional trials.

3.2.7 Ranking Phase. The eight neutral images were presented in their static forms and in pairs (and in random order for each participant), and the participant merely had to say which of the two images they preferred or neither image by pressing a corresponding key. Every combination of pairs was presented (28 trials in all). The computer logged a 1-point rank value for each picture that was preferred. The maximum rank value for a picture could therefore be 7 and the minimum 0. The ranking phase occurred before and after learning trials.

3.2.8 Attentional Trials Phase. In this phase, two pictures were presented at the same time, one on the left of the monitor and one on the right. The pairs consisted of either one smiling and one frowning face, or one ideograph previously paired with a smiling face and one ideograph previously paired with a frowning face. All pictures were those used in the learning phase, but this time pictures were shown in their static form. Participants were required to fixate on a central cross on the screen for 1000 ms before the pictures appeared. The pictures remained visible until a key was pressed or for 2000 ms if no key was pressed. Before this and 500 ms after the pictures appeared, a small image of ladybird appeared on one of the pictures and the participant's task was to press the *a* key if the target appeared on the left picture, and the *5* key on the numeric keypad of the keyboard if the target appeared on the right picture. There was a 1500 ms inter-trial interval before the fixation point appeared. Since there were four different smiling faces and four different frowning faces, we paired up every combination, including reversing their left/right positions, which is a total of 12 trials. We did the same for the pairs of ideographs, which added another 12 trials. Each pair was then shown twice, making a total of 48 trials. Reaction times to respond to the target were recorded, as well as the eye fixations throughout the attention trials.

3.3 Results

3.3.1 BAI and MASC

Overall, 43 BAI forms were returned by mothers and 32 by fathers, and 41 MASCs were completed. The mean scores of the BAI showed that mothers had significantly higher scores than fathers, $t(30) = 2.813, p < .01$. The BAI of mothers correlated with many other measures, such as the BAI of the father, $r(32) = .388, p < .05$; the MASC total score, $r(41) = .335, p < .05$; and Physical Symptoms, $r(41) = .546, p < .001$. Apart from correlating with the mother's BAI score, the father's BAI scores correlated only with

Physical Symptoms, $r(32) = .46, p < .001$.

3.3.2 Evaluative Learning

The mean rank values for pictures paired with smiling faces and for those paired with frowning faces were computed, and for both pre-learning and post-learning phases. A repeated measures ANOVA of time (pre-rank or post-rank scores) and valence (ideographs paired with smiling faces or ideographs paired with frowning faces), revealed an interaction between valence and time, $F(1, 43) = 4.62, p < .05$, such that ideographs paired with smiling faces showed an increase in liking after learning (M pre-learning = 3.67 and M post-learning = 4.18), and ideographs paired with frowning faces showed decrease in liking after learning (M pre-learning = 2.99 and M post-learning = 2.53).

We calculated an Evaluative Learning Index (ELI) in the same way we did in Experiment 1 in order to examine any relationship with the anxiety measures. We conducted a stepwise multiple-regression analysis on the ELI with parental BAI and MASC subscales as the main predictor variables. There was a highly statistically significant association between Panic/Separation Anxiety and BAI of the mother on the ELI [Multiple $R = 0.359; F(2, 28) = 7.841, p < .002$. Together, Panic/Separation Anxiety and Mother's BAI accounted for 35.9% of the variance. Both variables were positively associated with the ELI. The regression coefficient beta for Panic/Separation Anxiety was 0.131 ($t = 2.832, p < .01$); and for Mother's BAI beta was 0.125 ($t = 2.078, p = .05$). In sum, Panic/Separation Anxiety and Mother's BAI predict the overall magnitude of evaluative learning. In order to determine whether more vulnerable children showed a bias to learn the negative associations better than the positive associations, we conducted separate regression analyses for a positive ELI and a negative ELI. These revealed no significant associations.

To be sure that vulnerable children were not biased to learn negative associations more quickly than positive associations, we split participants into two groups based on a median split of their Panic/Separation Anxiety (PSA) scores, split mothers according to a median split of their score on the BAI, and computed a multivariate ANOVA of PSA group x Mother's Anxiety group on the three dependent variables: overall ELI, positive ELI, and negative ELI. This analysis revealed a main effect of PSA group on negative ELI, $F(1, 36) = 5.789, p < .025$, with the low PSA group having a mean negative ELI of -0.636 , and the high group with a mean of 0.895 (the higher the value of the negative ELI, the greater is the amount of evaluative learning). There were no other main effects or interactions.

Reaction Time to Human Faces

The mean reaction times were calculated for each participant according to the type of trial. A mixed ANOVA on reaction time to emotional faces, with valence of the face as the within-subjects variable and PSA group and Mother's BAI group as the between-subjects variables revealed no main effects or interactions. Thus, there was no preferential looking for human smiling or frowning faces. Since using the individual

measures dichotomously does not exploit the full range of scores, we carried out a paired t -test on valence alone. This did not reveal a significant difference in reaction time. We next computed a reaction time index (RTI) by: reaction time when the target was in the location of a smiling face minus the reaction time when the target was in the location of a frowning face. A positive RTI implies that the participants were mostly viewing the frowning faces by the time the targets appeared, and a negative RTI implies that the participants were mostly viewing the smiling faces by the time the target appeared. We then carried out a stepwise multiple regression on RTI with Mother's BAI and PSA as the first block of predictor variables, and the remaining anxiety measures as the second block of predictor variables. No variable entered at .05.

3.3.3 Reaction Time to Ideographs Imbued with Valence

A mixed ANOVA on reaction time to the ideographs, with valence of the associated facial expression as the within-subjects variable and PSA group and Mother's BAI group as the between-subject variables, revealed a highly significant interaction between PSA and valence, $F(1, 36) = 8.407, p < .01$. The high PSA group were quicker to respond to the target when it appeared in the location of an ideograph paired with a frowning face ($M = 751$ ms) than when it appeared in the location of an ideograph with a smiling face ($M = 882$ ms). The opposite effect occurred with the low PSA group who were quicker to respond to the target when it appeared in the location of an ideograph paired with a smiling face ($M = 721$ ms) than when it appeared in the location of an ideograph paired with a frowning face ($M = 825$ ms). To corroborate this finding, we computed a reaction time index (RTI): reaction time when the target was in the location of an ideograph paired with a smiling face less the reaction time when the target was in the location of an ideograph paired with a frowning face. A positive RTI implies that the participants were mostly viewing the frowning faces by the time the targets appeared, and a negative RTI implies that the participants were mostly viewing the smiling faces by the time the target appeared. We then conducted a stepwise linear regression with Mother's BAI and the child's PSA as the main predictor variables, and the other anxiety measures as secondary predictor variables. There was a highly statistically significant positive association between PSA on the RTI, Multiple $R = 0.402$; $F(1, 38) = 7.309, p < .01$. PSA accounted for 40% of the variance and was negatively associated with the reaction time index. The regression coefficient beta for PSA was 0.402 ($t = -2.704, p < .01$). Thus, PSA predicts reaction time and shows that as PSA increases, there is an increased attentional preference for ideographs that were previously associated with frowning faces.

Eye Movements

We recorded the first eye fixations on each trial and calculated the mean fixations for each participant based on the trial type. For trials with pictures of human faces, we then conducted an ANOVA on mean number of first fixations with valence as a within-subjects measure and PSA group and Mother's BAI group as between-subjects factors. This time we found a main effect of valence, $F(1, 36) = 6.489, p < .025$, such that participants tended to fixate first on frowning human faces ($M = 1.09$) rather than on smiling faces ($M = 0.69$). Therefore, unlike the reaction time data, the eye movement

data implies that on the whole participants tended to fixate on the frowning faces earlier than the smiling faces. To determine whether any individual measures of anxiety predicted orientation, we computed a fixation index (number of first fixations to frowning faces less the number of first fixations to the smiling faces) and ran a regression analysis. No variable entered at .05. Thus, in line with the reaction time data, there does not appear to be any preferential attending to emotional faces that is predicted by any measure of anxiety.

Next we conducted an ANOVA on mean number of first fixations on the ideographs, with valence of the ideograph's pair as a within-subjects measure and PSA group and Mother's BAI group as between-subject variables. There was a significant interaction between PSA group and valence, $F(1, 36) = 6.318, p < .025$, such that the high PSA group tended to fixate first on ideographs paired with frowning faces (M frowning = 3.64, M smiling = 3.0), and the low group tended to fixate first on ideographs paired with smiling faces (M smiling = 3.73, M frowning = 2.53). There were no other main effects or interactions. We conducted a regression analysis on a fixation index (computed by number of first fixations on ideographs paired with frowning faces less the number of first fixations on ideographs paired with smiling faces) with the anxiety measures as predictor variables, but no measure entered at .05.

4. Discussion

The results obtained can be summarised in the following way: The participants as a whole demonstrated evaluative learning, however, Panic/Separation Anxiety and the mother's anxiety predicted the overall magnitude of evaluative learning. Furthermore, children high on Panic/Separation Anxiety showed stronger evaluative learning with frowning faces than did children low on this measure. In terms of attention, there was a tendency for the group as a whole to attend to frowning faces before smiling faces; however, Panic/Separation Anxiety and mother's anxiety predicted attentional vigilance for frowning faces, and children high on Panic/Separation Anxiety tended to fixate more on ideographs that predicted frowning faces than did children low on this measure. This experiment has therefore revealed important differences between children high and low on PSA in learning and attention. We have therefore identified learning and attentional biases in children prone to separation anxiety. Given the importance of this result we carried out a replication with a number of modifications.

5. EXPERIMENT 3

In this experiment, we attempted to examine whether stimuli imbued with valence would acquire the capacity to hold greater attention in children more vulnerable to anxiety than with less vulnerable children. The evaluative learning trials differed from the previous experiment because we wished to exploit the Yiend and Mathews (2001) paradigm, which is a location based task. The idea is to present a target image in a different location from the emotional stimulus and then measure the time it takes to respond to the target. Slowed responses imply slower disengagement from the emotional stimulus. Hence the method warranted evaluative learning trials with the neutral and affective stimuli

appearing at different locations. For this reason, it was not feasible to use the morphing procedure of the previous two experiments. Instead, we used the standard paradigm used in visual evaluative learning, which is to pair static images. Although we were unsure as to whether we would observe evaluative learning under these conditions, the method did allow us to compare evaluative learning when the affective stimulus and the neutral stimulus are presented at the same or different locations, which is something that has not been examined in previous studies. Using this method, we were able to assess the amount of disengagement from affective stimuli as well as stimuli that had been previously associated with other affective stimuli between children with various anxiety-related dispositions.

5.1 Method

5.1.1 Participants

Participants were 34 children (19 boys and 15 girls) in the 7-8 year range. The children were sampled from six local schools in the UK (four urban and two rural). As with the previous experiments, signed permission to participate was obtained from the main caregiver as well as from the child. A brief outline of the main task and the type of materials that would be shown was presented before requesting permission. The experimental procedure was approved by the Ethics Committee at University of Worcester and The Worcestershire NHS Ethics Committee. Recruitment from each school was via a random sampling procedure, where each child who had opted in had an equal chance of being selected (with the constraint that we required equal numbers of boys and girls). All children showed willingness to participate. Donations were made to each participating school, and the amount was based on the number of children tested. Each child was given a small toy for their participation.

5.1.2 Materials

Twelve abstract images created with imaging and drawing software were used for the neutral stimuli. These consisted of different shapes, colours, and textures. Two constraints governed their creation: They should have an abstract appearance, and they should be highly distinctive from each other. Eight of the 12 neutral images were used as neutral stimuli for evaluative learning trials, and four were used as novel stimuli in the attention trials. Four photographs of smiling faces and four photographs of angry faces were used, and these were the same as those in the previous experiments. BAI and MASC measures were also taken as in the previous experiment. We also used the same eye tracking equipment as in Experiment 2. However, in 80% of trials, the participant made a response without making a fixation on (or even towards) the target. Since so many made use of parafoveal vision, we collected too little data to be able to conduct any useful analysis on eye movements. One possible explanation for this might be that the stimuli used were less visually demanding or interesting than those used in the previous experiment where the images were constantly moving. The results section is based only on ranking and reaction time data, therefore.

5.1.3 Procedure

There were four phases in this experiment: pre-ranking, learning, attention trials, and post-ranking.

5.1.4 Pre- and Post-Ranking. The ranking procedure used for the pre- and post-ranking phases was the same as that used in Experiment 2.

5.1.5 Learning Phase. Each of the eight neutral pictures was consistently paired with one of the pictures of a human face. Furthermore, this pairing either occurred in the same location or at a different location on the monitor. On each trial, the neutral picture appeared on the left side of the monitor, and the face appeared either on the left side or the right side of the monitor, replacing the first picture. In the previous experiments, we obtained evaluative learning in only two trials using the morphing procedure, and we expected this owing to the visual potency of the images. However, with static images we suspected that more trials would be required to achieve evaluative learning (based on previous reported experiments) and hence there were 4 learning trials for each stimulus pair. These were separated four learning blocks so that the same pair did not appear consecutively. Pairings were counterbalanced across participants in the same way as the previous experiment. The location of the picture of the face was also counterbalanced across participants.

5.1.6 Attention Trials . The attentional trials began with the presentation of one of the images for 2 s, after which a small arrow appeared that pointed up or down in either the same location or on the right of the picture. When the arrow appeared at the same location, the picture was removed. When the arrow appeared at the different location, the picture remained on for a further 2 s or until a key was pressed. There was a 1500 ms inter-trial interval. The participant's task was to detect whether the arrow was pointing up or down by pressing a corresponding key on the keyboard. On valid trials, the probe appears at the same location as the picture, and hence responses should be quick regardless of valence. On invalid trials, the probe appeared at a different location, and hence the time taken to respond to the probe is indicative of the time to disengage from the picture. Long response times to detect the probe implies greater attentional engagement (and hence slowed disengagement) to the picture.

5.2 Results

5.2.1 BAI and MASC

Overall, 33 BAI forms were returned by mothers and 26 by fathers, and 34 MASCs were completed. The BAI of the mother correlated with three of the other measures: with Physical Symptoms, $r(33) = .548, p < .001$; with Social Anxiety, $r(33) = .361, p < .05$; and with Panic/Separation Anxiety, $r(33) = .388, p < .05$. The father's BAI correlated only with Physical symptoms, $r(26) = .423, p < .05$. All MASC subscales correlated with each other at .05, except Harm Avoidance, which did not correlate with any other

measure.

5.2.2 Evaluative Learning

We computed the overall rank values for each neutral picture, noting the valence of the face it was paired with, whether the paired face appeared in the same or different location, and whether the ranking was done pre- or post-learning. We computed a repeated measures ANOVA of location of the face (same or different), valence of the face (smiling or frowning), and time (pre- or post-learning). There was a highly significant interaction between valence and time, $F(1, 33) = 53.82, p < .001$. Ideographs paired with smiling faces showed an increase in liking after learning (M pre-learning = 2.97 and M post-learning = 4.97), and ideographs paired with frowning faces showed decrease in liking after learning (M pre-learning = 3.72 and M post-learning = 1.95). There were no other main effects or interactions.

We computed correlations between PSA and the ELI (computed in the same way as in the previous experiments), as well as between BAI of the Mother with the ELI, to determine whether those relationships found in Experiment 2 were present with this sample. PSA correlated significantly and positively with the ELI, $r(34) = .356, p < .05$, and while BAI scores of mothers was positively correlated with ELI, it was not statistically significant, $r(33) = .187, p > .05$. Moreover, a regression analysis on ELI with the anxiety measures as predictor variables failed to reveal a significant predictor variable at .05. Likewise, no predictor variables entered at .05 on positive ELI or negative ELI.

5.2.3 Reaction Time to Emotional Faces

We calculated a Fixation Index, FI, by reaction time to respond to the target when a frowning face was present less reaction time to respond to the target when a smiling face was present. A positive FI implies greater fixation time on frowning faces than on smiling faces, and a negative FI implies the reverse. We computed a univariate ANOVA on FI with PSA group and Mother's BAI group as independent variables. The only significant effect was a main effect of PSA group, $F(1, 30) = 11.399, p < .002$. The low PSA group had a mean FI of -264.9 , implying longer fixations on smiling faces than on frowning faces, while the high PSA group had a mean FI of 133.2 , implying longer fixations on frowning faces than on smiling faces. This was confirmed by a multiple regression analysis on FI, with Mother's BAI and PSA as primary predictor variables and the remaining anxiety measures as secondary predictor variables, with only PSA positively associated with FI, $F(1, 23) = 9.414, p < .005$; beta 20.3, and PSA accounted for 26% of the variance. Furthermore, PSA correlated highly significantly and positively with the FI, $r(34) = .567, p < .001$, and although the BAI of the mother was positively correlated with FI, it was not statistically significant, $r(33) = .176, p > .05$. Thus, in these analyses, higher PSA scores are associated with longer fixation times on frowning faces.

5.2.4 Reaction Time to Ideographs Imbued With Valence

Next, we computed the FI for invalid trials with ideographs in the same way as above, and carried out a univariate ANOVA on FI with PSA group and Mother's BAI group as independent variables. The only near-to-significant effect was that of PSA group, $F(1, 30) = 3.599, p = .067$. To test this further, we carried out a similar multiple regression analysis as above, but no variable entered at .05. This was confirmed by correlational analyses, which showed that there was no significant correlation between FI and PSA, $r(34) = -.138, p > .05$, nor was there a significant correlation between BAI of the mother and FI, $r(33) = -.108, p > .05$. In order to determine whether the participants as a whole showed any preferential attention before responding to the target, we conducted a one-sample t -test on the FI, but it did not differ significantly from 0, $t(33) = -1.204, p > .05$. Thus, there was no consequential effect of evaluative learning on attention in this experiment.

5.3 Discussion

Similar to the findings of Experiment 2, a strong evaluative learning effect was demonstrated by the sample as a whole but with Panic/Separation Anxiety associated with the magnitude of evaluative learning, although the mother's anxiety did not interact significantly in this experiment. Panic/Separation Anxiety was also associated with longer fixation times on frowning faces, and children high on this measure had a slower disengagement from them than children low on the measure. Unlike Experiment 2, where there were effects on attention in anxiety of stimuli imbued with valence, there were no such effects here.

6. GENERAL DISCUSSION

All three experiments revealed that children as young as 7-8 years can learn to like and dislike through evaluative learning, and Experiment 1 shows that children appear to learn associations without any awareness of the stimulus contingencies. This is consistent with the many previous findings and supports the contention that evaluative learning is an implicit form of learning. Experiments 2 showed that although most of the children changed their preferences as a result of being exposed to the associations, there is an evaluative learning bias in anxious children (high on Panic/Separation Anxiety, PSA), which interacted with the mother's anxiety. Furthermore, it appears that this bias takes the form of inflated learning of negative associations in high PSA children. These results are consistent with the causal hypothesis because they show firstly that the mother's anxiety level can predict the strength of evaluative learning and secondly that anxious children have a evaluative learning bias for negative information. Experiments 2 also demonstrated that attentional bias is associated with the child's anxiety (PSA). This finding mirrors that found in adults, but places the focus on separation anxiety. The third experiment showed that children with high PSA were slow to disengage from threatening material, a finding that also mirrors the effect found in adults, but again places the focus on separation anxiety.

Of all the subscales of the MASC, only separation anxiety was associated with the dependent measures. Separation anxiety was associated with the strength of evaluative

learning, attentional bias, and disengagement failure. These findings support those perspectives that postulate a major role for separation anxiety in the development of adult anxiety. One way of testing this further, other than through a longitudinal study, is to use a retrospective measure of separation anxiety on adults (e.g., the Separation Anxiety Symptom Inventory, Silove et al., 1993) to determine whether those who score higher on this measure show the same learning and attention biases as did the high PSA children in this study.

What may be of particular interest in the development of anxiety, is the finding in Experiment 2 that greater attention is paid to the *predictors* of threat (stimuli imbued with valence) by children high on PSA, while all children tended to direct attention to the threat itself (angry faces). Thus, this could imply that children with separation anxiety, borrowing a term from the classical conditioning literature, show an enhanced *anticipatory* effect in learning. One explanation of this effect is that the inflated evaluative learning for negative associations with high PSA promotes attentional bias to those stimuli. However, equally possible is that negative stimuli attract greater attentional resources and this leads to increased evaluative learning for those stimuli. Further research could determine whether evaluative learning bias promotes an attentional bias or the other way around by comparing fixation times on neutral stimuli in negative associations and neutral stimuli in positive associations.

Experiment 3 shows that high PSA children show slowed disengagement from with threatening pictures, and again this mirrors the effect found in adult anxiety. There was no slowed disengagement to stimuli acquiring negative valence when compared with stimuli acquiring positive valence. Combining this result with the attentional bias towards stimuli imbued with negative valence, stimuli with imbued valence may have less potency than an overtly threatening stimulus; so while they capture attention, they do not hold it. An alternative explanation is that a stimulus imbued with negative valence (via evaluative learning) is also one that predicts the occurrence of a negative stimulus. The result is that they may capture less sustained attention than an overt threat. One way of examining this issue further would be to record eye movements during learning and to interleave learning and attentional trials. This way, it may be possible to construct a more detailed picture of the effects of evaluative learning on attention as imbued valence is developed over time. This may uncover any relationship between rates of learning and vulnerability to anxiety that may exist.

Our study implies a cognitive style in anxious (high PSA) children that appears to take the following pattern: (1) They learn rapidly about negative information, (2) they selectively attend to *predictors* of threat, and (3) they are slow to disengage from threatening material. Evaluative learning is therefore an important learning mechanism through which an attentional bias for threat may be spread or transferred to other previously innocuous stimuli. Taken together, the results from the experiments provide support for a learning mechanism in the development of attentional bias. The study also demonstrates associations between maternal anxiety, child separation anxiety, evaluative

learning, and attentional bias in children. A longitudinal study on the present sample may help to determine which of these come to be good predictors of adult anxiety.

As mentioned in the introduction, many studies demonstrate that evaluative learning can operate without awareness of the stimulus contingencies. Our study shows that such learning in children may also operate outside of awareness. In the case of an evaluative learning bias, this implies that it may be difficult to repair. The question also arises as to whether there are differences in contingency awareness between high and low anxious individuals. It may be, for example, that anxiety and contingency awareness are positively associated. Furthermore, previous studies show that when participants are informed of the relationship between neutral stimuli and paired affective stimuli, learning is inhibited (Fulcher & Hammerl, 2001). One question is whether such inhibition applies equally to high and low anxious individuals.

Finally, Mathews and colleagues (e.g., Yiend & Mathews, 2002) have addressed the question of whether cognitive biases have a causal role in anxiety by attempting to induce cognitive bias in non-anxious individuals. Since such cognitive training increases anxiety, it is reasonable to suppose that cognitive biases are a contributory factor in the development of anxiety disorders. The question the present study raises is whether a similar induced evaluative learning bias can promote attentional bias and levels of anxiety. If so, then there exists the prospect of using evaluative learning techniques in therapy.

In conclusion, we have identified that children with a degree of separation anxiety show a learning bias that mainly concerns the acquisition of negative emotional information and an attentional preference for learned signals of threat. Therefore, in order to understand the development and maintenance of anxiety further, it seems important to understand the role of evaluative learning in anxiety.

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