

# Children's subjective emotional reactivity to affective pictures: gender differences and their antisocial correlates in an unselected sample of 7–11-year-olds

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**Background:** Differential responses in terms of gender and antisocial behaviour in emotional reactivity to affective pictures using the International Affective Picture System (IAPS) have been demonstrated in adult and adolescent samples. Moreover, a quadratic relationship between the arousal (intensity) and valence (degree of unpleasantness) has been suggested. The picture perception methodology has rarely been applied to middle school-aged children. We examined the subjective ratings of emotional reactivity in children for: i) the relationship between arousal and valence, ii) gender differences, and iii) its association with measures of antisocial behaviour. **Method:** Twenty-seven IAPS pictures were selected to cover a wide range of affective content and were individually administered to a non-referred community sample of 659 7–11-year-old children using a paper-and-pencil version. Concurrent symptoms of conduct disorder, oppositional defiance and psychopathy were collected from multiple sources (teacher-, parent- and self-report). **Results:** A quadratic relationship between arousal and valence, similar to that previously reported in adults, was demonstrated. A gender difference was found for valence ratings, with girls rating aversive pictures more unpleasant than boys. No gender differences for arousal ratings were found. A significant difference was found between groups scoring above and below cut-off scores on measures of antisocial behaviour. Children above cut-off reported lower arousal to unpleasant pictures, but higher arousal to pleasant pictures. **Conclusions:** We confirmed that a paper-and-pencil version of the IAPS for evaluating emotion response to affectively valent and arousing stimuli can be used in school settings and that comparable gender differences in emotional reactivity can be found in children. The differential emotional reactivity of children above cut-off on measures of antisocial behaviour suggested these symptoms to be associated with a combination of increased reward and decreased punishment sensitivity. **Keywords:** IAPS, picture perception methodology, arousal, valence, antisocial behaviour. **Abbreviations:** APSD: Antisocial Process Screening Device; IAPS: International Affective Picture System; ODD: oppositional defiant disorder; SAM: Self-Assessment Manikin; SDQ: Strengths and Difficulties Questionnaire.

The International Affective Picture System (IAPS) is a set of visual stimuli for use in experimental investigations of emotion and attention. In using the affective picture perception methodology, researchers are able to develop and extend theories on the differential physiological and behavioural reactions associated with emotion that may stem from the activation of basic motivational systems controlling approach/appetite or defence/withdrawal (Cacioppo & Bernston, 1994; Lang et al., 1998).

Many studies have shown a consistent pattern in adults' verbal, behavioural and physiological responses to the affective pictures contained in the IAPS (Bradley et al., 1990; Lang et al., 1993, 1998; Bradley et al., 2001a). In these studies, adults were asked to subjectively report on two dimensions of their emotional reactions to affective pictures: valence (pleasure) and intensity (arousal). These two dimensions in emotional perception have been found to correlate with corrugator muscle activity in the face, skin conductance, heart rate, startle response, EEG, MRI and PET (Lang et al., 1998).

In addition, gender differences have been found in the ways which men and women respond to affective pictures (Bradley et al., 2001b). Women are more reactive to unpleasant pictures at a physiological level, and rate these pictures as more unpleasant and arousing. In contrast, men tend to be more reactive to pleasant pictures in both subjective report and physiological response.

A new line of research using the IAPS concerns the relationship between emotional reactivity and antisocial behaviour. For example, in response to unpleasant pictures, psychopathic adults have been found to show similar subjective responses to normal controls, despite under-arousal in their psychophysiological reactions (Patrick et al., 1993; Herpertz et al., 2001).

Similarly, it has been suggested from picture stimulus studies that 'acquired psychopathy' (i.e., following head injury and brain lesion) leading to reactive aggression is associated with impairments in executive emotional systems whereas 'developmental psychopathy' (i.e., lifetime tendency to goal-directed

instrumental aggression) shows deficits in emotional unconditioned stimuli, particularly distress cues (Blair, 1999), and conditioned stimuli (Blair, 2001). These studies, using affectively valent picture stimuli, suggest that there are important differences between normal and abnormal groups of individuals in the recognition and processing of emotionally valent information. Studies have shown different patterns of relationships between the valence (pleasant or unpleasant) and the reaction (levels of arousal or intensity) to an emotional picture scene. Importantly, the concurrent measures of psychological and physiological reactivity have demonstrated dissociations between psychological reporting and autonomic change in the recognition, appraisal and response to emotions of differing valences (Blair et al., 1997; Levenston & Patrick, 1997; Fowles, 2000; Blair, 2001). Of particular importance to developmental psychopathologists is the notion that there are distinct emotion processes between patients with autism (impaired ability to represent the referent of the individual displaying the emotion) and conduct disorder (response to fearful and sad expressions is attenuated with a loss of social learning and no resultant motivation to avoid actions that result in harm to others) and in turn between these and acquired psychopathic tendencies (response to angry expressions in particular is attenuated, resulting in reduced regulation of previously learned social behaviour) (Blair, 2003).

The picture perception methodology used in this work is increasingly being applied to children to investigate whether group and individual differences in emotional reactivity can be demonstrated (e.g. Blair, 1999). For example, severe conduct disordered children and those with psychopathic tendencies show lower arousal to unpleasant stimuli and distress cues compared to controls, suggesting a neurophysiological deficit in fear modulation (van Goozen et al., 2004b) or a postulated violence inhibition mechanism (VIM; Blair, 1995).

To date, all the child studies have been on small samples selected for current and frequently severe, behavioural disturbance. Thus we know little of the normative relations between arousal and valence of affective stimuli in the child population at large and its relation to measures of antisocial behaviour. To extend the use of this paradigm to primary school children requires firstly a demonstration that IAPS pictures of varying valence and arousal elicit the same patterns of subjective responses as in normal adults.

Only one published study has addressed this issue (McManis et al., 2001). They compared subjective responses to IAPS pictures for three age groups: 7–11-year-olds ( $n = 64$ ), 12–14 years ( $n = 62$ ) and 18–23 years ( $n = 20$ ). In a first experiment children rated pictures using the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) which provides dimensional scales for subjective pleasure and arousal

responses. They found a similar quadratic relationship (boomerang-shaped scatterplot) between the pleasure and arousal dimensions across all three age groups that was predicted by previous work in adults (Lang et al., 1999). In a subsequent experiment with a new sample of 7–10-year-olds ( $n = 30$ ) it was found that children rated pleasant, neutral and unpleasant pictures differently in terms of pleasure and arousal, as predicted. Emotional pictures were rated as more arousing than neutral pictures. However, in experiment 2 children rated the pleasant pictures as more arousing than unpleasant pictures, whereas the opposite pattern was found in experiment 1. Furthermore, a gender difference – similar to that reported in adults (Bradley et al., 2001b) – was reported. Girls rated aversive pictures more unpleasant than did boys, but rated pleasant and neutral pictures as more pleasurable than boys. In contrast, there were no gender differences in arousal ratings.

This study makes an important contribution in demonstrating that children can use the paper-and-pencil version of the SAM (Bradley & Lang, 1994) to make dimensional ratings of pleasure and arousal similar to adults. However, the sample sizes were small and further studies are needed to confirm that the method is sufficiently efficient and valid in a community setting to establish children's normative evaluative responses to affective stimuli (Bradley & Lang, 1994).

The current study, conducted in a large unselected community cohort of 7–11-year-old British children ( $n = 659$ ), aims to determine if: i) There is a quadratic relationship (boomerang-shaped scatter plot) between arousal and valence in a non-referred population; ii) There are sex differences in arousal, valence or both measures of the test. We expected girls to rate unpleasant pictures as more unpleasant than boys. In contrast, compared to girls, we expected boys to be more reactive to pleasant pictures; iii) There is an association between subjective ratings of emotional reactivity and measures of antisocial behaviour obtained from parents, teachers and the subject. Adult offenders have been shown not to differ in their self-report ratings to affective pictures (Patrick et al., 1993). However, this may not be true for young children with high behaviour scores, who may not have yet learned to report high arousal to unpleasant pictures as this is socially more desirable than appearing unmoved by aversive stimuli.

## Method

### Participants

The current study is part of a larger-scale study of the social-cognitive and emotional correlates of antisocial behaviour in community children (the Child Behaviour Study). Parents of 2950 7–11-year-olds of 16 primary

schools in Cambridgeshire, England, were asked to participate. An average of 20% (response rates for individual schools ranged from 14% to 40%) of parents volunteered their children to take part in the study ( $n = 659$ ; 319 boys and 340 girls).

There are four possible reasons to explain the low response rate. First, the ethics approval requirements prohibit researchers to gain access to names and addresses of parents in the community. Invitation letters to participate in the study were therefore handed out to children at school to take home to their parents. It is possible that many invitation letters did not make it home in the first place. Second, ethics in the UK require positive consent. The effort of completing and returning a consent form to indicate positive consent may be too much to ask of busy parents in the community. Third, limited resources precluded payment to children for their participation. Instead, children were given a sticker and were entered into a school raffle draw for participation. Fourth, it is possible that parents feel more protective of children in the below-11 age range compared with adolescents, where the response rate for community studies using a school-based ascertainment procedures in the UK is typically 50% (Goodyer et al., 2000).

Two procedures were employed to determine whether the low response rate introduced a bias into the recruitment procedure. First, the school board on which parents were represented gave permission for teachers of one of the schools to anonymously complete a child behaviour measure (the Strengths and Difficulties Questionnaire, SDQ; Goodman, 1997; Goodman et al., 2000; Goodman, 2001) on all the children in the school. Those children whose families volunteered could then be compared with those children whose parents did not volunteer. Independent sample  $t$ -tests showed no significant differences ( $p > .05$ ) between the volunteers ( $n = 61$ ) and non-volunteers ( $n = 232$ ) on all 5 scales of the SDQ (Hyperactivity, Emotional Symptoms, Conduct Problems, Peer Problems, Prosocial).

Second, comparison of sociodemographic characteristics also revealed no evidence of participation bias. The mean age of the sample was 9 years 3 months ( $SD = 1$  year 2 months), mean IQ was 105 ( $SD = 15$ ) and there were 319 boys (48%) and 340 girls (52%). The ethnic distribution in the sample was in line with regional statistics (Office of National Statistics, 1991) for Eastern England (97% white, 2% Asian, .5% black and .5% oriental). To determine socio-economic status, we used a geodemographic tool called ACORN which is freely available on the Internet. ACORN categorises all 1.9 million UK postcodes, which have been described using over 125 demographic statistics within England, Scotland, Wales and Northern Ireland, and 287 lifestyle variables, making it a powerful discriminator for social class. According to ACORN our sample comprised of 40% wealthy achievers, 9% urban prosperity, 28% comfortably well-off, 9% moderate means and 14% hard pressed.

## Measures

**IAPS.** Based on normative responses to the IAPS in 7–11-year-olds as published in the IAPS manual (Lang

et al., 1999), 27 pictures were selected to cover a wide range of affective content. Pictures covered all nine categories of pleasure (high, medium, low)  $\times$  arousal (high, medium, low), with 3 pictures in each category. All pictures were mounted as A4 photographs in colour with high figure/ground contrast to facilitate discrimination of relevant features. Child psychologists reviewed the pictures for age appropriateness. Photographs were set in a fixed sequence, randomly determined in advance and the same for all participants. Data was complete for the full sample ( $n = 659$ ).

### *Parent- and teacher-reported behaviour difficulties.*

i) Parents and teachers completed the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997; Goodman et al., 2000; Goodman, 2001). The SDQ was specifically designed to screen for psychiatric disorders in community samples and was shown to identify individuals with psychiatric diagnosis with a specificity of 94.6% (95% CI 94.1–95.1%) and a sensitivity of 63.3% (59.7–66.9%) (Goodman et al., 2000). Sensitivity for the SDQ has been demonstrated to be especially good (70–90%) for identification of conduct-oppositional disorders and hyperactivity disorders. For the purposes of this analysis we used the cut-off scores on the Conduct subscale provided by Goodman et al. (2000) to compute a binary variable that indicates high and low scorers.

ii) Mild behaviour difficulties were measured with a 19-item questionnaire derived from the DSM-IV criteria of Oppositional Defiant Disorder. The relationship between teacher- and parent-report on this questionnaire was significant ( $r = .21$ ;  $p .005$ ). Teacher-report correlated significantly with teacher ( $r = .60$ ;  $p < .001$ ) and parent ( $r = .25$ ;  $p < .001$ ) SDQ conduct scores. Parent-report correlated significantly with parent ( $r = .24$ ;  $p < .001$ ) and teacher ( $r = .28$ ;  $p < .001$ ) SDQ conduct scores. A binary variable (high/not high) was created by grouping children into two groups using a 90th percentile cut-off.

### *Parent- and teacher-reported psychopathy.*

The Antisocial Process Screening Device (APSD; Frick & Hare, 2001) formerly known as the Psychopathy Screening Device (PSD; Frick et al., 1994) was completed by parents and teachers. The instrument consists of 20 items each rated as 0 (not at all true), 1 (sometimes true) or 2 (definitely true), giving a total score ranging from 0 to 40. For theoretical reasons, in addition to using the total APSD score, researchers often use the callous-unemotional subscale score to distinguish a sub-sample of high-scoring children who have been shown to be more severe and persistent in their psychopathic behaviour compared with low scorers on the callous-unemotional subscale. We therefore use both the total APSD and the callous-unemotional subscale score for analyses. Binary variables (high/not high) were created by grouping children into two groups using 90th percentile cut-offs.

**Self reported behaviour difficulties.** Children were asked to complete (i) ten self-report questions on current disruptive behaviour derived from the DSM IV

criteria for conduct disorder and (ii) the same 19-item questionnaire derived from the DSM-IV criteria of Oppositional Defiant Disorder (ODD) described above for teacher- and parent-report. For both these measures binary variables (high/not high) were created by grouping children into two groups using a 90th percentile cut-off.

### Procedures

To test the efficacy of the IAPS to elicit similar responses in school settings as previously reported for laboratory settings, rigorous experimental conditions (dark room, computer-based task administration) were not upheld. Individual assessment took place in a quiet room at school with adequate lighting. Photographs were mounted on a stand and shown for 10 seconds with 10-second intervals between photographs. As suggested by the manual, children were trained to use the SAM on a practice trial. Following McManis et al.'s (2001) example, words like happy, pleased, or good, and unhappy, scared, angry, bad or sad were used in the instructions to describe the endpoints of the pleasure scales. Words like calm, relaxed, bored, or sleepy and excited, nervous or wide-awake described the endpoints for the arousal scale.

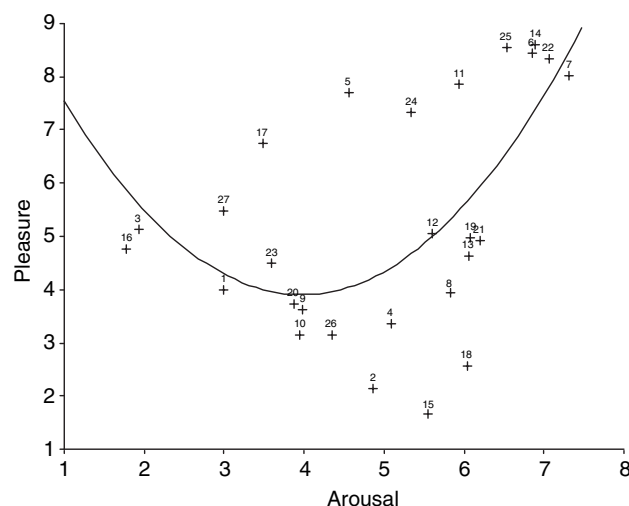
Parent report was obtained through the post. Teacher report was obtained during the period of assessment in a particular school.

## Results

### Affective ratings

Since 3 pictures were selected *a priori* to represent each of the 9 categories on the basis of normative results published in the IAPS manual, we first investigated whether the 27 pictures we chose indeed covered the full range of affective pleasure and arousal. In doing so, we expected the 27 pictures to display a quadratic relationship when pleasure and arousal are plotted against each other. Figure 1 illustrates the location of each picture in a two-dimensional affective space defined by the mean pleasure and arousal ratings. Visual inspection of the curve fit line suggests that the relationship between arousal and pleasure ratings is quadratic. This was confirmed by curve fit statistics which were significant ( $F = 7.64$ ;  $df = 24$ ;  $p = .003$ ). By fitting a quadratic model to the data the amount of variance explained ( $R^2 = .39$ ) more than doubled compared to that explained by the linear model ( $R^2 = .16$ ).

Findings across picture types were similar to those previously reported in both adults (Lang et al., 1998) and children (Lang et al., 1999; McManis et al., 2001). Thus the work on adults and children predicted the following pictures to have high arousal and low pleasure ratings: 2 = AIDS patient, 15 = burn victim, 18 = gun attack. The normative mean valence ratings in the IAPS manual for these pictures are 2.02 (SD = 1.30), 1.60 (SD = 1.07), and 2.14 (SD = 2.11). The valence ratings in the current study



**Figure 1** Mean pleasure and arousal ratings of 27 selected IAPS pictures. *Note (original IAPS numbers stated in parentheses):* 1 = old man (2490), 2 = AIDS patient (3230), 3 = fork (7080), 4 = soldier (9421), 5 = girl with watermelon (7325), 6 = ice cream (7330), 7 = roller coaster (8490), 8 = pit bull (1300), 9 = cemetery (9001), 10 = smoking in jail (2722), 11 = ice lollies (7390), 12 = rock climber (8160), 13 = lightning (5950), 14 = dolphins (1920), 15 = burn victim (3100), 16 = basket (7010), 17 = flowers (5030), 18 = aimed gun (3500), 19 = bear (1321), 20 = screaming boy (2810), 21 = snake (1120), 22 = fireworks (5480), 23 = mother and boy (2312), 24 = sports car (8510), 25 = puppies (1710), 26 = pizza and cockroach (7380), 27 = boat on lake (5390)

were 2.15 (SD = 1.67), 1.65 (SD = 1.66) and 2.57 (SD = 2.38) – an almost perfect match with Lang et al.'s normative ratings.

In contrast, the arousal ratings for unpleasant, high arousal pictures (pictures 2, 15 and 18) in our sample were lower and the SDs larger than those previously found. On the basis of the normative ratings in the manual we expected the following means for these pictures: 5.41 (SD = 2.21), 6.49 (SD = 2.23) and 7.22 (SD = 2.67). The arousal ratings in our sample for pictures 2, 15 and 18 were 4.87 (SD = 2.78), 5.55 (SD = 3.24), and 6.04 (SD = 3.00). The sample Lang et al. used to produce their normative ratings consisted of 36 7–9-year-olds. Our sample consists of 659 7–11-year-olds. We therefore investigated whether age had an effect on arousal ratings. A Spearman correlation for age and mean arousal by picture type revealed significant correlations for all picture types: unpleasant ( $r = .14$ ;  $p < .001$ ), pleasant ( $r = -.10$ ;  $p = .008$ ), neutral ( $r = -.19$ ,  $p < .001$ ). In this sample, children's arousal ratings to unpleasant pictures increase with age, whereas ratings to pleasant or neutral pictures decrease.

Where our sample did not differ from the sample used to produce norms in the IAPS manual is that our sample still rated unpleasant pictures more arousing and unpleasant than neutral pictures. Table 1 sum-

**Table 1** Mean arousal and valence ratings by picture type

	Arousal			Valence		
	Full sample ( <i>n</i> = 659)	Boys ( <i>n</i> = 319)	Girls ( <i>n</i> = 340)	Full sample ( <i>n</i> = 659)	Boys ( <i>n</i> = 319)	Girls ( <i>n</i> = 340)
Pleasant	7.01 (2.06)	7.02 (2.01)	7.01 (2.11)	8.36 (.95)	8.30 (1.02)	8.40 (.88)
Neutral	2.24 (1.57)	2.33 (1.66)	2.14 (1.47)	5.15 (1.79)	5.20 (1.76)	5.11 (1.81)
Unpleasant	5.48 (2.36)	5.45 (2.35)	5.51 (2.38)	2.12 (1.41)	2.44 (1.62)	1.82 (1.11)

The values are given as *m* (SD).

marises the arousal and valence means and SDs for the three picture types (pleasant, neutral, unpleasant) for the sample as a whole and then by gender. The mean ratings were significantly different across picture type for both arousal (K-W,  $\chi^2 = 7.20$ ; *df* = 2; *p* = .027) and valence ratings (K-W,  $\chi^2 = 7.20$ ; *df* = 2; *p* = .027). Children rated pleasant pictures significantly more arousing than both neutral and unpleasant pictures, and unpleasant pictures were rated as more arousing than neutral pictures, but less arousing than pleasant pictures.

There were no differences (Mann-Whitney) between boys and girls in the arousal ratings for any of the picture types. Gender differences were, however, found for valence ratings for unpleasant pictures (*z* = -5.29; *p* < .001) with girls > boys.

#### Affective ratings and measures of antisocial behaviour

We next investigated the relationship between subjective arousal ratings and the measures of antisocial behaviour. Pleasant and unpleasant pictures (more so than the neutral pictures) provided the stimulus to highlight possible relationships between arousal and measures of antisocial behaviour, with that relationship being in the expected direction. Table 2 summarises the results.

For unpleasant pictures, children above cut-off for teacher-reported conduct problems showed significantly *lower* mean arousal ratings compared with children below cut-off. Similar findings were present for teacher-reported oppositional defiance and parent- and teacher-reported psychopathy. There were no differences between groups (above and below the 90th percentile) for callous-unemotional traits on arousal ratings for any of the 3 types of pictures.

For pleasant pictures, children above cut-off on teacher-reported conduct scores reported significantly *higher* arousal ratings than children below cut-off. The same pattern was found for oppositional defiance.

A cross-tabulation with conduct and psychopathy scores showed that 44% of children above cut-off on the conduct measure were also above cut-off on psychopathy, whilst 42% of children above cut-off on conduct scores were above cut-off on the oppositional defiance measure. These three measures therefore seem to indicate different populations, despite an amount of overlap.

**Table 2** Differences in mean arousal ratings between below and above cut-off scores on measures of antisocial behaviour from multiple sources

	Unpleasant pictures ( <i>z</i> )	Pleasant pictures ( <i>z</i> )	Neutral pictures ( <i>z</i> )
T-Conduct			
Above cut-off	4.34 (2.72)	7.64 (1.94)	2.19 (1.52)
Below cut-off	5.60 (2.31)	7.01 (2.04)	2.66 (1.96)
Mann-Whitney	-3.15**	-2.70**	-1.24
P-Conduct			
Above cut-off	5.11 (2.70)	7.10 (2.01)	2.44 (1.69)
Below cut-off	5.49 (2.28)	7.04 (2.01)	2.15 (1.50)
Mann-Whitney	-1.16	-.52	-1.56
C-Conduct			
Above cut-off	5.37 (2.47)	7.12 (2.05)	2.80 (2.11)
Below cut-off	5.49 (2.36)	7.01 (2.05)	2.17 (1.49)
Mann-Whitney	-1.17	-.24	-1.95
T-ODB			
Above cut-off	4.33 (2.00)	7.38 (2.36)	2.86 (1.93)
Below cut-off	6.00 (2.16)	6.62 (2.26)	2.15 (1.53)
Mann-Whitney	-4.10**	-2.64**	-1.35
P-ODB			
Above cut-off	5.56 (2.18)	7.30 (2.10)	2.27 (1.45)
Below cut-off	5.80 (2.28)	6.77 (2.14)	2.21 (1.54)
Mann-Whitney	-.13	-1.67	-1.38
C-ODB			
Above cut-off	5.31 (2.43)	7.42 (1.81)	2.35 (1.79)
Below cut-off	5.50 (2.34)	6.91 (2.11)	2.13 (1.48)
Mann-Whitney	-.52	-1.75	-.58
T-APSD Tot			
Above cut-off	4.71 (2.55)	6.91 (2.65)	2.73 (2.12)
Below cut-off	5.92 (2.14)	6.66 (2.24)	2.14 (1.50)
Mann-Whitney	-2.28*	-.97	-.95
P-APSD Tot			
Above cut-off	4.60 (2.50)	6.76 (2.31)	2.41 (1.76)
Below cut-off	5.60 (2.32)	6.97 (2.03)	2.12 (1.49)
Mann-Whitney	-2.19*	-.46	-1.13
T-APSD CU			
Above cut-off	5.16 (2.46)	6.62 (2.70)	2.15 (1.48)
Below cut-off	5.89 (2.16)	6.69 (2.23)	2.55 (2.24)
Mann-Whitney	-1.36	-.24	-.19
P-APSD CU			
Above cut-off	4.92 (2.57)	6.47 (2.15)	2.13 (1.51)
Below cut-off	5.55 (2.31)	7.01 (2.03)	2.14 (1.50)
Mann-Whitney	-1.73	-1.78	-.28

\*\**p* < .01; \**p* < .05.

T = Teacher report; P = Parent report; ODB = Oppositional Defiant Behaviour; APSD Tot = Antisocial Process Screening Device Total Score; APSD CU = Antisocial Process Screening Device Callous-Unemotional Subscale Score.

The values are given as *m* (SD).

To further investigate the relationship between antisocial problems and arousal ratings we carried out a series of logistic regressions for each of the teacher-reported antisocial measures and age,

gender and arousal ratings as independent variables (gender was included due to differences between boys and girls on the behaviour measures; age was entered due to the age effect on arousal ratings reported earlier). We first present the results for the unpleasant pictures.

*Unpleasant pictures.* With group membership (above or below cut-off) on teacher-reported conduct problems as the response variable, the best fit for the model was additive with gender ( $B = .64$  [ $SE = .31$ ]; Wald = 4.16;  $df = 1$ ;  $p = .04$ ; OR =  $1.9 \pm 1.0$ –3.5) and arousal ( $B = -.22$  [ $SE = .06$ ]; Wald = 11.65;  $df = 1$ ;  $p = .001$ ; OR =  $1.2 \pm 1.0$ –1.4). Age was dropped from this model. Thus being male and having reduced arousal ratings increased the likelihood of being above cut-off for conduct problems.

When teacher-reported psychopathy was entered as the outcome variable, both gender and age were dropped from the model, with arousal retained as the only significant predictor of psychopathy group membership ( $B = -.24$  [ $SE = .10$ ]; Wald = 5.30;  $df = 1$ ;  $p = .02$ ; OR =  $1.3 \pm 1.0$ –1.5). Unlike conduct problems, both boys and girls with low arousal were likely to be above cut-off on psychopathy.

The fact that the children above cut-off on the psychopathy measure consisted of 38% girls and 62% boys suggests that psychopathy traits (which, as measured by psychopathy measures, supposedly distinguish a sub-group of children with conduct problems) are predicted by reduced low arousal ratings in both boys and girls.

For teacher-reported oppositional defiant behaviour both age and gender were dropped from the model with arousal remaining a significant predictor ( $B = -.39$  [ $SE = .10$ ]; Wald = 14.38;  $df = 1$ ;  $p < .001$ ; OR =  $1.5 \pm 1.2$ –1.8); 44% of children above cut-off for oppositional defiance were girls.

*Pleasant pictures.* The logistic regression with teacher-reported conduct scores as outcome variable and arousal ratings (in response to pleasant pictures), gender and age as independent variables mirrored the results for unpleasant pictures. Both gender ( $B = .65$  [ $SE = .31$ ]; Wald = 4.31;  $df = 1$ ;  $p = .04$ ; OR =  $1.9 \pm 1.0$ –3.5) and arousal ( $B = .19$  [ $SE = .09$ ]; Wald = 4.31;  $df = 1$ ;  $p = .04$ ; OR =  $.8 \pm .7$ –1.0) were retained. Being male and reporting higher arousal ratings to pleasant pictures increased the likelihood of being above cut-off.

With teacher-reported oppositional defiance as outcome variable both age and gender were dropped from the model, with arousal ratings the only significant predictor ( $B = .24$  [ $SE = .12$ ]; Wald = 3.74;  $df = 1$ ;  $p = .05$ ; OR =  $.8 \pm .6$ –1.0). Higher arousal ratings to pleasant pictures therefore increased the likelihood of being rated above cut-off for oppositional defiance for both boys and girls.

## Discussion

The current study has demonstrated that a paper-and-pencil version of the IAPS test is both feasible and efficient when given to a large sample of children in a school setting. Despite the low response rate in our sample selection and that representativeness can thus not be claimed, no evidence of participation bias was found and our results are generalisable to typical community settings in Eastern England.

### *Relationship between valence and arousal ratings*

As predicted by work with adults (Lang et al., 1998) and children (McManis et al., 2001), a quadratic relationship (boomerang-shaped scatterplot) was demonstrated between the pleasure and arousal dimensions. We also replicated the finding that primary school children rated pleasant, neutral and unpleasant pictures differently in terms of valence and arousal. Children rated the pleasant pictures as more arousing than unpleasant pictures. This supports experiment 2 of McManis et al.'s (2001) findings, but not that of experiment 1 where the authors found an opposite pattern. The fact that our sample size is larger may account for this conflicting result. The findings confirm a quadratic relation between valence and arousal for both sexes in this age range. Children of this age do indeed rate pleasant pictures as more arousing than unpleasant pictures.

### *Sex differences and age effects*

In line with research on adults (Bradley et al., 2001b) and McManis et al.'s (2001) findings, girls in the current study rated aversive pictures as more unpleasant than boys. In contrast, they did not rate pleasant and neutral pictures as more pleasant than boys. The previously reported gender difference may have been due to small sample size. In line with previous research, no gender difference was found for arousal ratings.

The current study found that children's arousal ratings to unpleasant pictures increase with age, but ratings to pleasant or neutral pictures decrease with age. It may be that as children grow older they learn to give a more socially desirable response to aversive pictures. Alternatively, older children may find aversive pictures more arousing than do younger children.

Overall in this community sample the findings support the hypothesis that compared to boys, girls show higher arousal ratings for unpleasant pictures. In contrast, there is no support for a sex difference in ratings of pleasant pictures (hypothesis 2). In addition, there are complex age effects on arousal which suggests a power issue, or a developmental process on emotion reactivity, that require further investigation.

### Valence and arousal ratings and antisocial behaviour

Patrick et al. (1993) found that psychopaths (compared to controls) report similar levels of psychological arousal to unpleasant pictures, but were under-aroused on psychophysiology measures. Blair (1999) reported the same for adolescents with psychopathic tendencies who had been excluded from mainstream schools. In the current study we found a relationship between reported under-arousal and above cut-off scores on antisocial measures (especially as reported by teachers) for 7–11-year-old community children. A series of logistic regression analyses showed a relationship between self-reported under-arousal and those in the 'high' group on teacher-reported oppositional defiance and psychopathy for both sexes independent of age. In contrast, the relationship with conduct problems was true only for boys, again independent of age. The relationship between under-arousal and antisocial measures may reflect a core trait association. The type of behavioural measurement may influence the nature of any associations. Thus a sex difference may be only apparent amongst certain antisocial groups and less so amongst others.

So far, very few studies have been conducted in children with conduct and other behavioural disorders, but the evidence from the current study together with previous psychophysiological findings (van Goozen et al., 2004b) are in line with an explanation in terms of an associated dysfunctional fear modulation system. It has been suggested that a lack of fear, as evidenced, for example, by low levels of autonomic arousal, would predispose children to antisocial behaviour because low fear of socialising punishment would reduce the effectiveness of conditioning (Raine, 1993). Fowles (1980) suggested that skin conductance is a marker of punishment sensitivity, and that antisocial individuals have problems in processing punishment but are hyper-sensitive to reward (Fowles, 2000; Newman et al., 1987; Newman & Wallace, 1993). Recently we concluded that severe conduct disorder (CD) in childhood is associated with a combination of increased reward and decreased punishment sensitivity (van Goozen et al., 2004a). CD children's sensitivity to reward enabled them to postpone impulsive behaviour that would have resulted in more immediate, but less favourable consequences, but also that they ignored increasingly strong punishment signals once their reward sensitivity had been extensively reinforced.

The present finding is the first in a community sample to show significantly higher rates of reported arousal to pleasant pictures by children with high behavioural scores. This supports the theoretical suggestion that children with moderate and more severe conduct problems show a hyper-sensitivity to reward.

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