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**How can we use knowledge about the neurobiology of emotion recognition in practice?**

Laura M. Hunnikin<sup>a</sup> & Stephanie H. M. van Goozen<sup>a, b\*</sup>

<sup>a</sup> *School of Psychology, Cardiff University, Cardiff, United Kingdom*

<sup>b</sup> *Department of Clinical Child and Adolescent Studies, Leiden University, Leiden, Netherlands*

\*Corresponding author

Email address: [vangozens@cardiff.ac.uk](mailto:vangozens@cardiff.ac.uk) (S.H.M. van Goozen)

Phone number: [029 208 74630](tel:02920874630) (S.H.M. van Goozen)

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**Abstract**

Children with antisocial behaviour show consistent emotion recognition difficulties that are thought to contribute to their aggressive and negative behaviours. Current treatments for antisocial youths are limited in effectiveness but research is beginning to show that emotion recognition training is a viable treatment option. This article considers the role of emotion recognition in antisocial behaviour, the neurobiological factors thought to contribute to emotion recognition impairments and current research showing that training these individuals to recognise emotions in others represents a feasible and potentially successful treatment option. We have outlined a program of research that once implemented will improve our understanding of the causal role of emotion recognition in the development of serious and persistent antisocial behaviour in youth.

**Keywords:** *Emotion recognition; early intervention; neurobiology; amygdala; aggression*

39 Antisocial behaviour (ASB) in childhood and adolescence is associated with a range  
40 of negative outcomes in adulthood. Not only does it predict future arrests, crime severity  
41 and conviction rates (Huesmann, Eron, & Dubow, 2002), but also substance abuse and  
42 dependence, persistent health problems and psychiatric illness, amongst others. These  
43 negative outcomes and associated crimes are costly to society by increasing the strain on  
44 both police and medical resources, while these individuals require extra educational  
45 provisions, state benefits and residential care (Scott, Knapp, Henderson, & Maughan, 2001).  
46 For these reasons, intervention strategies and support for young people with aggressive and  
47 antisocial behavioural problems are highly desirable.

48 We know that a small group of children and adolescents is at high risk for persistent  
49 ASB, including repeated involvement in the justice system. Judicial figures of criminality  
50 indicate that 80% of UK crime is being committed by this small group of individuals who  
51 exhibited behavioural problems in childhood and adolescence (Sainsbury Centre for Mental  
52 Health, 2009). Recent reviews of evidence from neuroscience (Fairchild, van Goozen, Calder,  
53 & Goodyer, 2013), clinical science, forensic psychology, and criminology (Skeem, Scott, &  
54 Mulvey, 2014) indicate that high-risk juveniles differ from other young people in degree,  
55 rather than kind; they have poorer parental supervision, come from more disadvantaged  
56 neighbourhoods, have greater problems in emotion function and exhibit alterations in brain  
57 structure and function. However, research challenges the notion that high-risk children  
58 inevitably mature into adult offenders (Odgers et al., 2007), raising the possibility that well-  
59 targeted treatments could create a turning point in ASB for high-risk juveniles. Interventions  
60 delivered early in childhood and targeted towards impairments that influence aggressive  
61 behaviours represent the best potential for preventing this developmental trajectory to  
62 persistent ASB (van Goozen & Fairchild, 2008; White, Frick, Lawing, & Bauer, 2013;  
63 Wilkinson, Waller, & Viding, 2015).

#### 64 **A case for emotion recognition**

65 *Why is emotion recognition important?*

66 Being able to detect, process and respond appropriately to the emotions of others is  
67 crucial for normal social interaction (Corden, Critchley, Skuse, & Dolan, 2009; Fridlund,  
68 1991). Interpreting another's facial displays of emotion provides insight into their thoughts,  
69 beliefs, and intentions and allows one to explain and interpret their behaviour. An aptitude

70 in emotion recognition helps to initiate and maintain healthy social relationships and to  
71 participate successfully in a range of life activities and social situations (Izard et al., 2001;  
72 Leppänen & Hietanen, 2001; McClure & Nowicki, 2001). Indeed, young children who are  
73 good in recognising other people's emotions are more socially skilled and popular  
74 (Manstead & Edwards, 1992).

75 *How is emotion recognition learned?*

76 Recognition of others' emotions is learned through experience and based on the  
77 gradual refinement with age of children's production and recognition of emotional signals  
78 (Moulson et al., 2015; Pollak, Cicchetti, Hornung, & Reed, 2000; van Goozen, 2015).  
79 Caregivers play a substantial role in developing their child's emotion recognition proficiency.  
80 Not only do caregivers expose children to many emotional facial expressions (Malatesta,  
81 1985), particularly by modelling and mirroring emotional expressions (DeOliveira, Bailey,  
82 Moran, & Pederson, 2004), they also provide situational context and behavioural responses  
83 to emotional expressions, enabling children to learn the meaning of emotional expressions  
84 (Pollak & Sinha, 2002). Importantly, aberrant caregivers show positive emotional  
85 expressions less frequently and negative emotional expressions more frequently and as a  
86 result children who are adversely treated or exposed to these aberrant emotional signals  
87 exhibit a range of emotion recognition difficulties (Pollak et al., 2000; Shackman & Pollak,  
88 2014). For example, Forslund and colleagues (Forslund, Kenward, Granqvist, Gredebäck, &  
89 Brocki, 2016) showed that attachment type is important in the development of emotion  
90 recognition, and that those categorised as having a disorganised attachment style showed a  
91 diminished ability to identify facial emotional expressions.

92 The influence of parenting on the development of emotion recognition may help to  
93 explain why children with certain mental health problems, including those who show  
94 aggressive and antisocial behaviour, have emotion recognition impairments. Poor parenting  
95 is a known risk factor in the development of aggressive behaviour (Weiss, Dodge, Bates, &  
96 Pettit, 1992), affecting – among others - emotional appraisal processes and predisposing  
97 children to attribute hostile intent (Dishion, French and Patterson, 1995; Dodge, 1993;  
98 Dodge & Pettit, 2003; Nelson & Coyne, 2009).

99                    *Impairments in emotion recognition and ASB*

100                    There is substantial evidence that individuals who engage in inappropriate  
101 interpersonal behaviour have problems in facial emotion recognition (Marsh & Blair, 2008).  
102 This has been reported in a wide variety of antisocial populations, ranging from  
103 psychopathic adults (Blair et al., 2004; Glass & Newman, 2006) to children high in  
104 psychopathic traits (Blair, Colledge, Murray, & Mitchell, 2001). Typically these populations  
105 are impaired at recognising fear and sadness (Blair & Coles, 2000; Blair et al., 2004, 2001;  
106 Marsh & Blair, 2008; Montagne et al., 2005), anger (Fairchild, van Goozen, Calder, Stollery,  
107 & Goodyer, 2009; Schönberg, Louis, Mayer, & Jusyte, 2013) and disgust (Kosson, Suchy,  
108 Mayer, & Libby, 2002). Some researchers have found evidence of pervasive impairments for  
109 negative emotions in general (Bowen et al., 2014) and in all basic emotions (Dawel,  
110 O’Kearney, McKone, & Palermo, 2012). In a recent study in young offenders we found  
111 support for poor emotion recognition across differing intensities, but in particular poor  
112 recognition of low intensity anger and high intensity fear expressions (Bowen et al., 2014).

113                    *Theories linking emotion recognition and ASB*

114                    A deficiency in understanding the emotions of others may be causally linked to ASB,  
115 as proposed by Blair’s (2005) Integrated Emotion Systems (IES) model. Accordingly, distress  
116 cues, such as fear and sadness, serve to inhibit ASB. Specifically, the correct processing of  
117 others’ distress-related cues is thought to elicit empathy that, in turn, results in learning to  
118 avoid aggressive acts that cause fear and sadness. Indeed, the inability to experience  
119 another’s distress vicariously or to empathise with another person affectively has been  
120 identified as a possible cause of ASB (Decety & Jackson, 2003). Importantly, Bons et al.  
121 (2013) showed that emotion impairments for negative emotions are specific for children  
122 with Conduct Disorder. The findings by Bowen and colleagues (2014) also support this view;  
123 because angry faces serve as warning signals of social punishment, children at risk for ASB  
124 may be less sensitive to low intensity (early warning) signals and therefore continue to  
125 behave in socially unacceptable ways. The IES theory also states that these individuals are  
126 impaired in the formation of stimulus-reinforcement associations, meaning they do not  
127 create the association between the victim’s distress, their own negative feelings and their  
128 behaviour. All of this culminates in the development and continuation of their negative  
129 behaviours (see Figure 1).

130 Antisocial and aggressive individuals are not only impaired in recognising negative  
131 emotional facial expressions but they have also been found to interpret benign or neutral  
132 information as hostile (Crick & Dodge, 1994; Dodge, Pettit, Bates, & Valente, 1995). They are  
133 more likely to interpret an expression of disgust as angry (Sato, Uono, Matsuura, & Toichi,  
134 2009) and ambiguous expressions as angry (Mellentin, Dervisevic, Stenager, Pilegaard, &  
135 Kirk, 2015; Schönenberg & Jusyte, 2014). This ‘hostile attribution bias’ may lead them to be  
136 more likely to be involved in aggressive situations, thereby contributing to ASB.

137 Damasio’s somatic marker theory (Damasio, Tranel, & Damasio, 1991) proposes that  
138 somatic markers help in decision-making scenarios when emotions are involved. Different  
139 regions are involved in the generation of somatic markers but the primary inducer is  
140 thought to be the amygdala. When this area is damaged, the somatic response to emotional  
141 objects or events is limited, meaning the individual experiences limited physiological  
142 feedback relating to their current situation and is unable to learn the association between  
143 their behaviour and their physiological reaction. It is thought that this too contributes to the  
144 development and continuation of ASB. Indeed, there is extensive research evidence that  
145 shows that, for example, children with Conduct Disorder generally show low physiological  
146 arousal to affective pictures and/or a blunted cortisol stress response when negatively  
147 challenged (Fairchild et al., 2013; van Goozen, et al., 2000; Van Goozen et al., 2004). This is  
148 also linked to the observation of more impulsive, fearless and aggressive temperaments  
149 (van Goozen, 2015) and an inability to learn which situations should be avoided (Syngelaki  
150 et al., 2013), meaning they are more likely to engage in aggression, particularly to obtain  
151 rewards and social status (Raine, 2002).

### 152 *Neurobiology of ASB and emotion recognition*

153 The amygdala is thought to be an important area in the brain for emotion  
154 recognition. In neuropsychological studies, individuals with damage to the amygdala have  
155 been found to be less able to recognise negative facial expressions, particularly fear but also  
156 anger, disgust and sadness (Adolphs et al., 1999; Fairchild et al., 2013; Schmolck & Squire,  
157 2001). Functional imaging studies with healthy populations have also shown an activation of  
158 the amygdala in response to fearful stimuli (Breiter et al., 1996; Morris et al., 1996; Whalen  
159 et al., 2001). This, combined with the knowledge that the amygdala is activated when  
160 individuals view negative facial expressions or pictures (Whalen et al., 2001), has led to the

161 belief that the amygdala is important for processing threat information. Importantly,  
162 structural scans of young people who display ASB have shown an amygdala dysfunction  
163 (Fairchild et al., 2011; Jones et al., 2009; Marsh et al., 2008; Sterzer, Stadler, Krebs,  
164 Kleinschmidt, & Poustka, 2005). Fairchild et al. (2011) showed that structural amygdala  
165 abnormalities were present in adolescents with Conduct Disorder, no matter whether their  
166 disorder was of child or adolescent onset, compared to healthy adolescents. In their meta-  
167 analysis of 20 studies, Marsh and Blair (2008) found a robust link between ASB and specific  
168 deficits in the recognition of fearful expressions, which the authors suggest is linked to this  
169 amygdala dysfunction. Evidence of this dysfunction also supports Blair's (2005) IES model  
170 because the amygdala is thought to be involved in the formation of stimulus-reinforcement  
171 associations, thus it not only impairs the ability to recognise these distress cues but also to  
172 learn from them.

173 Evidence of pervasive impairments (Dawel et al., 2012) appear to be at odds with  
174 theories linking amygdala dysfunction to ASB via a deficit in distress recognition - however,  
175 further evidence suggests that the amygdala not only responds to fear but to a range of  
176 facial expressions (Fitzgerald, Angstadt, Jelsone, Nathan, & Phan, 2006). Current theories  
177 suggest that the amygdala may play an important role in detecting salient and socially  
178 relevant information (*e.g.*, Adolphs, 2010) and therefore may contribute to pervasive  
179 emotion recognition impairments and not just threat processing. For example, amygdala  
180 damage has been associated with abnormal processing of the eye-region of faces in both  
181 laboratory (Adolphs et al., 2005) and real-life interactions (Spezio, Huang, Castelli, &  
182 Adolphs, 2007). Taken together, these findings suggest that a more general dysfunction in  
183 attentional mechanisms may underlie the facial emotion recognition deficits in those who  
184 show ASB (*e.g.*, Dadds et al., 2006). Since the eye-region is particularly important for the  
185 recognition of fear, more so than other emotions, this may explain why fear recognition  
186 appears to be selectively impaired (Adolphs et al., 2005). Importantly, reduced attention to  
187 the eye-region of faces has been observed in children (Dadds, Jambrak, Pasalich, Hawes, &  
188 Brennan, 2011) and adolescents high in callous-unemotional traits (Dadds, El Masry,  
189 Wimalaweera, & Guastella, 2008). If emotion recognition impairments associated with ASB  
190 are the result of attention dysfunction, then it may be possible to train individuals to pay

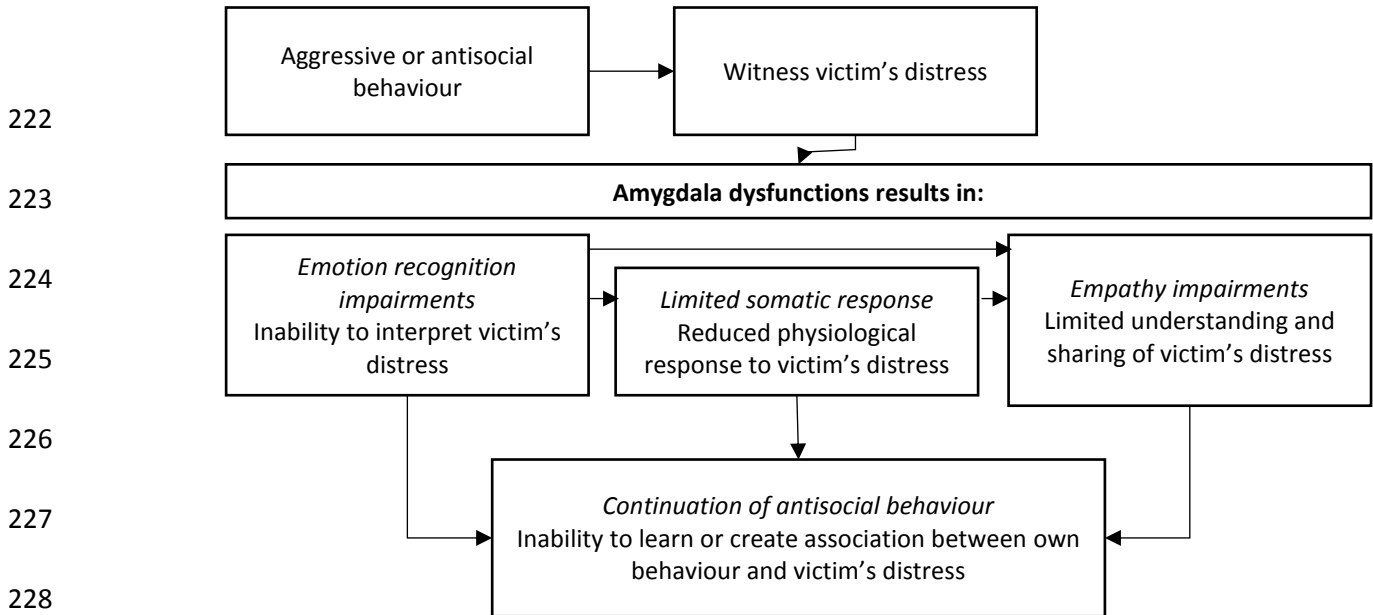


191 more attention to socially relevant information, thus improving recognition and potentially  
192 negative behaviour.

193 In a recent review, Marsh (2016) reconsidered the role of the amygdala in emotion  
194 recognition impairments, specifically in relation to fearful expressions. She posits that the  
195 amygdala's role in directing attention to salient information does not fully explain why  
196 fearful emotion recognition deficits have also been observed in other modalities such as  
197 vocal expressions (Blair, Budhani, Colledge, & Scott, 2005) or body postures (Muñoz, 2009).  
198 Instead an early hypothesis put forward by Adolphs and colleagues (Adolphs, Tranel,  
199 Damasio, & Damasio, 1995) provides a more thorough account of the role of the amygdala  
200 in fearful emotion recognition. Here, the amygdala is believed to be essential for linking  
201 perceptual representations of fear to internal representations of fear, via a process called  
202 emotional empathy or emotional contagion. An ability to identify and label stimuli as  
203 relating to fear is required to be able to link the external perceptual cue (the facial  
204 expression) to an internally generated representation of fear. In individuals with amygdala  
205 damage, it is thought that because they are impaired in experiencing fear (the internal  
206 representation), they struggle to label it in external cues, therefore being unable to link the  
207 external stimuli to the internal representation. The amygdala is not thought to be required  
208 for other emotions, such as disgust or anger, because it is not involved in generating internal  
209 representations for these emotions. Marsh suggests that the amygdala is essential for basic  
210 forms of empathy relating to fear. However, evidence of pervasive impairments (Bowen et  
211 al., 2014; Dawel et al., 2012) is again at odds with the theory that the amygdala is only  
212 important for recognising fearful expressions. Indeed, it will be interesting to find out  
213 whether other brain areas are involved in empathic responses to other emotions, such as  
214 sadness, and whether these areas are also impaired in individuals who struggle with  
215 emotion recognition.

216 Overall, it appears that the amygdala plays a key role in emotion recognition  
217 abilities, specifically expressions of fear. Although it is yet unclear exactly how it influences  
218 this important social ability, it is possible that emotion recognition training programs that  
219 improve attention to salient facial features could positively affect emotion recognition  
220 and/or empathy.

221



229 *Figure 1. Schematic representation of the impact of amygdala dysfunctions on emotion recognition and the*  
 230 *continuation of antisocial behaviour*

231 **Existing interventions are not always effective**

232 There have been few randomized controlled trials in the UK of psychosocial violence  
 233 interventions in young offenders and these show either negative effects (Petrosino, Turpin-  
 234 Petrosino, Hollis-Peel, & Lavenberg, 2013) or (in the case of multi-systemic therapies; MST)  
 235 only moderate effectiveness (Butler, Baruch, Hickey, & Fonagy, 2011). Even the best  
 236 designed interventions only reduce serious juvenile offenders' recidivism by up to 13%  
 237 (Lipsey, Howell, Kelly, Chapman, & Carver, 2010). As Kazdin (1997) noted, making a  
 238 difference in the life of the individual is the efficacy benchmark that all interventions should  
 239 strive to achieve, but it is doubtful that current interventions are achieving this.

240 Early family/parent training programmes are one type of intervention that has been  
 241 used. Such programmes aim to improve the parent-child relationship and to reduce ASB by  
 242 helping parents to learn how to control aggressive behaviour. Whilst some studies have  
 243 shown that these programmes are effective in reducing ASB (for example, see Farrington &  
 244 Welsh, 2003), other studies have shown that it is not beneficial in reducing violence (for  
 245 example, see Bilukha et al., 2005). Overall, a meta-analysis found a small to moderate  
 246 impact of family/parenting interventions on reducing ASB (Piquero, Farrington, Welsh,  
 247 Tremblay, & Jennings, 2009). These programmes require extensive parental effort and some  
 248 parents cannot or will not participate with the treatment (Kazdin, 1997; Losel & Beelmann,  
 249 2003; Webster-Stratton, Reid, & Hammond, 2001).

250 Research has also looked at the effectiveness of multi-systemic therapy (MST), which  
251 is an intensive family-based intervention for young people with serious ASB designed to  
252 address the multifaceted nature of ASB. It aims to identify and address the functional origins  
253 of ASB and promote prosocial behaviour. Whilst it has been shown to be an effective  
254 treatment option in some studies (for example, see Butler, Baruch, Hickey, & Fonagy, 2011),  
255 other studies have been less positive. For example, Sundell et al. (2008) showed that there  
256 was no additional benefit of MST compared to treatment-as-usual in a group of adolescents  
257 who reached the criteria for conduct disorder. Similar findings were shown by Leschied  
258 (2002) who found no evidence of treatment effects in serious young offenders following  
259 participation in a MST program.

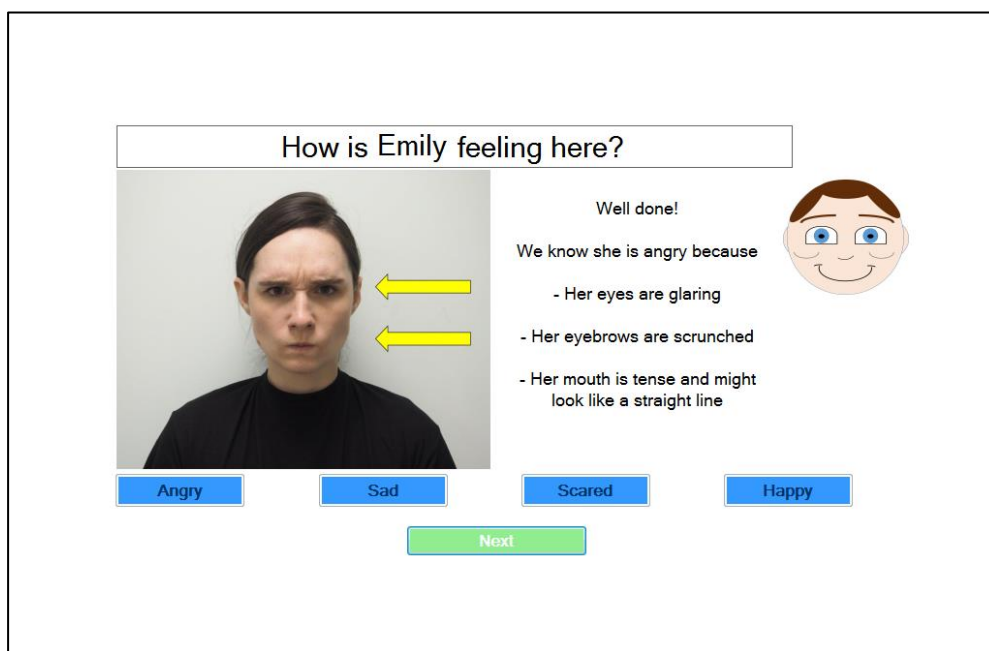
260 Most of these current interventions involve costly multiple sessions of face-to-face  
261 counselling or training over a period of several weeks or months, and the outcome  
262 measures of these studies rarely include crime or violence data. Even where reoffending  
263 data are collected, it is clear that the interventions do not work for everyone.

264 Another reason why existing interventions are not always effective is that the  
265 support young antisocial people receive is unlikely to be appropriately tailored to their  
266 individual symptoms and needs. As can be seen from the MST and parent training  
267 programmes, most current interventions target global risk factors and general social skills  
268 rather than specific socio-emotional dysfunctions that have been shown to be important in  
269 ASB (Moffitt, 2005; van Goozen, Fairchild, Snoek, & Harold, 2007). The causal status of most  
270 risk factors is currently unclear so instead, a focus on the underlying processes contributing  
271 to the behavioural problems is needed (the why or how?) (Moffitt, 2005). Understanding  
272 the psychological processes that contribute to persistent ASB and developing treatment  
273 programmes that address these will help to improve the effectiveness of these programmes  
274 (van Goozen et al., 2007). One area in which interventions can be targeted specifically to a  
275 socio-emotional dysfunction that is thought to influence their negative behaviours is  
276 emotion recognition.

### 277 **Emotion recognition training as a viable intervention**

278 Attempts to improve emotion recognition ability based on the hypothesis that  
279 impairments are due to attention dysfunctions to salient facial features have been carried  
280 out. Dadds et al. (2006) showed that directing boys with high levels of psychopathic traits to

281 look at the eyes significantly improved their fear recognition. Similar results have been  
282 reported with incarcerated male violent offenders when their attention was implicitly  
283 directed to salient facial features using dot-probe tasks (Schönenberg, Christian, et al.,  
284 2013). However, the longevity of this improvement in emotion recognition is unknown and  
285 any links to behaviour change were not investigated in these studies. Other research did  
286 include behavioural change measures following participation in emotion recognition training  
287 programs (see Table 1 for an overview) and have provided some evidence that emotion  
288 training is effective in young people with behavioural problems. One study (Dadds, Cauchi,  
289 Wimalaweera, Hawes, & Brennan, 2012) found a beneficial effect on parent and teacher  
290 reports of conduct problems (measured with a questionnaire, the Strengths and Difficulties  
291 Questionnaire; Goodman, 1997) in children with callous-unemotional traits. This is a  
292 distinctive subgroup that shows a more persistent pattern of problem behaviour reflecting a  
293 disregard for others and a lack of affect and empathy, similar to characteristics found in  
294 adult psychopathy. However, since the training involved close parent-child interactions that  
295 were not mirrored in the treatment-as-usual group, it is not known whether any benefits in  
296 training were due to improvements in relationships. Similarly, as the parents were involved  
297 in the training and the reporting on the behaviour change, it is possible that they were more  
298 positive in their evaluation of their child's behaviour.



299

300

Figure 2. Screenshot from the Cardiff Emotion Recognition Training (CERT) programme

301 Penton-Voak et al. (2013) were successful in modifying emotional cognitive biases of  
302 angry ambiguous expressions in aggressive youths, who subsequently reported fewer self-  
303 and staff-reported aggressive incidents in the two weeks following the intervention. The  
304 addition of staff-reported behaviour in this study is particularly useful given that the  
305 accuracy and honesty of self-reported behaviour can be questioned. Nevertheless, staff  
306 could only report on behaviour during weekdays leaving the behaviour of participants in the  
307 evenings and weekends when they are away from the context of social support and more  
308 able to commit official offences, unaccounted for.

309 Research from our own laboratory (Hubble, Bowen, Moore, & van Goozen, 2015)  
310 shows that fear, sadness and anger recognition can be improved in juvenile offenders as  
311 result of two hours of training. This computerised training programme, originally developed  
312 by Neumann and colleagues (Neumann, Babbage, Zupan, & Willer, 2014), directs attention  
313 to key facial features that are important for the correct processing and identification of  
314 basic emotions and was delivered in one-to-one sessions by a trained researcher. The  
315 programme also involves different activities such as identifying situations where the  
316 individual has felt specific emotions and engaging in emotional expression mimicry (See  
317 Figure 2 for a screenshot of a similar programme, the Cardiff Emotion Recognition Training  
318 or CERT programme). Importantly, this study was the first to demonstrate an effect of  
319 emotion recognition training on objectively recorded criminal behaviour in the form of a  
320 significant reduction in the severity of crimes committed in a 6-month follow-up period.

321 These more formal emotion recognition training programmes, that investigated the  
322 effects on subjectively reported or objectively recorded behaviour, have some key  
323 advantages. Firstly, they directly target the neuropsychological impairments that play a  
324 causal role in the development of ASB. Indeed, interventions of this type have been  
325 predicted to be successful in reducing aggressive and antisocial behaviour (White et al.,  
326 2013; Wilkinson et al., 2015). These type of interventions are also relatively short, requiring  
327 only a couple of sessions to complete, meaning they are less intrusive and less difficult to  
328 implement in everyday practice compared to, for example, family-oriented programmes  
329 (Kazdin & Wassell, 1999). Consequently, the costs of this type of intervention are relatively  
330 low, also because they can be delivered by teachers or family support workers.

331 *Outstanding matters for emotion recognition training programmes*

332 Overall, it is positive that short and focussed emotion recognition training  
333 programmes are beginning to show not only that emotion recognition can be improved, but  
334 also that these improvements may positively affect subsequent behaviour. However, the  
335 reason why a reduction in aggressive or offending behaviour occurs is currently unclear. It is  
336 possible that the improvement in the recognition of emotions in others reduces the hostility  
337 bias (i.e., one makes fewer mistakes and can correctly identify distress). It is also possible  
338 that the improved identification increases emotional understanding and empathy for  
339 others. Future studies need to examine these processes more thoroughly so we understand  
340 better how improved emotion recognition can lead to a reduction in aggressive and  
341 antisocial behaviour.

342 Emotion recognition training programs need to be offered in a tailored way so that  
343 those who need it most are receiving it. There is individual variation in emotion recognition  
344 performance, with some aggressive and antisocial individuals performing worse than others  
345 do (Bowen, Morgan, Moore, & van Goozen, 2014). This implies that the training might be  
346 more effective in those individuals who perform less well. Variation between individuals in  
347 behavioural change following participation in training programs could also be due to the  
348 influence of some moderating factors. For example, it has been hypothesised that  
349 individuals with higher levels of callousness are more likely to display impaired recognition  
350 abilities (Marsh et al., 2008) and it is possible that these individuals might benefit more from  
351 these training programs than others. As mentioned before, the early family environment  
352 plays an important role in the development of emotion recognition impairments. Children  
353 with emotional problems disproportionately come from disadvantaged and less supportive  
354 environments, and some of the characteristics of impaired emotional functioning are shared  
355 between parents and children, explaining the stability of antisocial behaviour over time  
356 (Sully, Sonuga-Barke, & Fairchild, 2015). The effectiveness of the emotion training might be  
357 greater if offered to those from affectively impoverished environments and/or whose  
358 families show similar emotion recognition deficits. In addition to personality and  
359 environmental factors, individual's level of empathic abilities and physiological reactivity  
360 must also be considered. For example, will the training have the same effect in children who  
361 do not pay attention to the eyes compared to those who show impaired affective

362 (physiological) reactivity? As ASB is associated with multifaceted risk factors and causes, the  
363 impact of these different factors will need to be considered in relation to treatment  
364 responsiveness.

365         Within the autism literature compensatory changes in neural activity, measured by  
366 fMRI, have been observed alongside improved recognition in those with autism trained to  
367 attend and interpret emotional faces (Bolte et al., 2006). It would be interesting to find out  
368 whether similar neural changes can be achieved in those with ASB and whether this has  
369 knock-on effects on the closely related-related domains of empathy and affective  
370 physiological reactivity.

371         We currently do not know whether emotion recognition training programs  
372 specifically affect certain types of crime. It seems likely that the training would affect  
373 interpersonal and emotion-related crimes rather than property related crimes. Hubble et al.  
374 (2015) argued that the reason that a reduction in re-offence severity was observed in their  
375 study was because more severe crimes typically involve physical aggression and  
376 interpersonal violence and these types of crimes were committed less frequently in the 6  
377 months following the emotion intervention. It is clear that emotion recognition difficulties  
378 play a greater role in interpersonal crimes where offenders can directly witness the  
379 emotional impact of their behaviour on the victim. More research using emotion  
380 interventions is needed to examine these crime specific issues.

381         Another area of research that needs to be considered involves the timing of the  
382 intervention, and whether early interventions to improve emotion recognition are effective  
383 and can prevent adverse development and outcome. Emotion recognition develops with  
384 age and intervening at a time when children are in the process of learning about emotional  
385 expressions could therefore be especially beneficial. The next section will consider the  
386 benefits of early intervention and why emotion training could provide a viable route for  
387 early intervention.

### 388                                 **Can emotion training be used as an early intervention?**

389                                 *Why is early intervention important?*

390                                 Interventions are currently reactive in nature, and most children with emotional and  
391 behavioural difficulties do not receive early intervention or receive it long after they really

392 need it. It is important to intervene early because antisocial individuals often start showing  
393 conduct problems early in life (Moffitt, 1993) and ASB in childhood predicts future ASB  
394 (Fombonne et al., 2001). It has been shown that interventions that seek to help individuals  
395 at-risk of emotional and behavioural difficulties lead to better outcomes than interventions  
396 delivered later in adolescence or adulthood (Skeem et al., 2014). For example, Hektner,  
397 August, Bloomquist, Lee and Klimes-Dougan (2014) showed that intervening in children  
398 aged, on average, 6 years old resulted in significantly fewer Conduct Disorder symptoms and  
399 increased social skills when they reached high school. Not only are early interventions likely  
400 to be more effective, they also show a cost-benefit. In February 2015 The Early Intervention  
401 Foundation (<http://www.eif.org.uk/our-work>), a UK charity to promote evidence-based  
402 early intervention programs, estimated that in England and Wales £17 billion is spent each  
403 year in addressing the problems that affect children and young people, including mental  
404 health problems, school refusal (truancy), youth crime and youth unemployment. The Early  
405 Intervention Foundation report 'Spending on Late Intervention: How can we can do better  
406 for less' ([http://www.eif.org.uk/publications/spending-on-late-intervention-how-we-can-](http://www.eif.org.uk/publications/spending-on-late-intervention-how-we-can-do-better-for-less/)  
407 [do-better-for-less/](http://www.eif.org.uk/publications/spending-on-late-intervention-how-we-can-do-better-for-less/)) examined the cost of 'late intervention' across a number of sectors  
408 including local authorities, education, the criminal justice system and the NHS. They found  
409 that local authorities carried the greatest cost (£6.5 billion), followed by welfare costs (£3.7  
410 billion) and NHS (£3 billion). Intervening early will therefore not only result in greater  
411 behavioural improvements but also represent a significant money-saving exercise.

412 *Can emotion training be used as an early intervention?*

413 Emotion recognition training represents a feasible early intervention strategy. These  
414 training programs are likely to be more effective when youths are targeted at an *early*  
415 sensitive period. The period between childhood and (early) adolescence is a time when  
416 children are particularly adept at specific kinds of social and emotional learning (Blakemore,  
417 2008). Brain processes that underlie social and emotional behaviour have not yet matured,  
418 meaning there is increased capacity for learning appropriate social and emotional behaviour  
419 (Spear, 2000). It is also during childhood that children naturally learn to recognise facial  
420 expressions in others. At 5-6 years of age, children are able to recognise facial expressions of  
421 happiness and sadness at an accuracy level similar to adults, whereas the ability to  
422 recognise fear does not develop until 7-8 years of age and anger develops around 9-10 years



423 of age (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). Childhood therefore  
424 represents a key period in which children are particularly adept to learn how to accurately  
425 recognise emotions in other people. Intervening at this time using emotion recognition  
426 training programs could prevent a series of self-reinforcing mechanisms from becoming  
427 entrenched, preventing, or at least reducing, the development of aggressive and antisocial  
428 behaviours and potentially improving positive capabilities such as empathy and pro-social  
429 behaviours (Foster, 2010). This sensitive period provides a crucial opportunity not only to  
430 help these youths attain a more positive developmental trajectory, but also to diminish the  
431 enormous negative impact they can have on society.

### 432 **Practical implications**

433 Research has shown that emotion recognition can be improved in youths who have  
434 come into contact with the police for a wide range of different types of antisocial behaviour  
435 problems by administering relatively brief, easy and targeted interventions that are cost-  
436 and resource-effective (Hubble et al., 2015). Individuals can be targeted to receive the  
437 intervention if they have proven to be impaired in emotion recognition, ensuring it is only  
438 provided to those who really need it. What is now needed for these interventions to be  
439 brought into mainstream practice is a greater understanding of the importance of emotion  
440 recognition, including the impairments shown and the impact these have on prosocial and  
441 antisocial behaviour. In addition, training programmes that are easily and readily available  
442 for wide-scale use need to be distributed amongst key individuals within youth offending  
443 services, primary and secondary schools, and those who work with high-risk children in  
444 other contexts, to allow for the aforementioned program of research to be implemented.

### 445 **Concluding comments and future research**

446 Antisocial behaviour in children is persistent and difficult to treat. Although some  
447 behavioural interventions have been shown to be effective in milder forms of these  
448 problems, their effectiveness in more seriously disturbed children is limited. This is partly  
449 because of the fact that we lack a comprehensive understanding of the cognitive and  
450 emotional problems of these children and the (neuro-) psychological causes of these  
451 difficulties. However, one thing we do know is that antisocial individuals have clear and  
452 pervasive impairments in emotion recognition. By offering treatments (such as emotion  
453 recognition training), that are tailored to the causal processes that influence the

454 development, persistence and severity of aggressive behaviour, we believe that there is a  
455 better chance of achieving beneficial and longer-term change for these individuals.

456         The juvenile justice system is undergoing reform and the role of emotions in criminal  
457 offending is beginning to be acknowledged. The juvenile justice reform movement needs to  
458 be complemented by research that addresses fundamental questions about *earlier*  
459 *intervention* and examines specific *mechanisms of change* that could lead to reductions in  
460 crime. Interventions could then target the psychological processes that contribute to  
461 antisocial development in high-risk children before they start to get involved in the criminal  
462 justice system. Emotion recognition training programs represent a developmentally  
463 sensitive, practically feasible risk reduction strategy for high-risk juveniles that focusses on  
464 emotion recognition as a mechanism that can be targeted for behaviour change. We have  
465 shown that teaching antisocial adolescents to recognise emotions in others is practically  
466 feasible and has positive effects on subsequent crime levels. In this paper, we have also  
467 outlined a research agenda for future research that prioritizes more targeted approaches,  
468 which involve screening for existing neuropsychological impairments and assessment of  
469 environmental risk factors that impact on neurodevelopment in those at risk for future  
470 antisocial behaviour.

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**Table 1. Current emotion recognition training programs for antisocial youth and their**

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**outcomes**

Facial emotion training program (Reference)	Program description	Sample	Outcomes
Facial affect recognition training (Hubble et al., 2015)	Computerised program to direct attention to relevant facial features; 2-3 sessions, total training time 2 hours.	24 male youth offenders (Training) and 26 male youth offenders (Control) (mean age = 16 years).	Significant improvement in the recognition of fear, sadness, and anger; significant decrease in the severity of crimes 6 months later.
MindReading (Dadds et al., 2012)	Daily parent-child interactional exercises and therapist sessions with computerised MindReading program; 4 x 90 minute sessions.	196 clinic-referred children and adolescents (mean age = 11 years) assigned to treatment-as-usual group ( $n = 109$ ) or emotion-recognition intervention ( $n = 87$ ).	Significantly greater improvement in conduct problems 6 months later, only in those displaying high levels of callous-unemotional traits. No differences in emotion recognition abilities post-training.
Modifying hostility biases (Penton-Voak et al., 2013)	Computerised program to modify automatic tendency to interpret ambiguous expressions as angry by adjusting balancing point of when an ambiguous face is classified as angry vs. happy; 4 sessions, unknown duration.	46 juveniles (mean age = 13 years; control group, $n = 23$ ; training group, $n = 23$ ) with histories of frequent aggressive behaviour and/or criminal records.	Significantly modified biases to encourage perception of happiness instead of anger in ambiguous pictures. Associated with a decrease in self-reported anger and aggression and in independently rated aggressive behaviour 2 weeks later.

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**How can we use knowledge about the neurobiology of emotion recognition in practice?**

**Highlights**

- There are currently limited effective treatment options for young people who engage in serious and persistent antisocial behaviour
- To improve outcome, treatments need to be tailored to the individual’s specific cognitive and emotional issues that contribute to their problem behaviour
- Improving emotion recognition represents a viable option for intervention.
- Research has begun to show that teaching antisocial youth to recognize emotions in others is associated with improved behaviour, including a reduction in re-offence severity.
- Research now needs to examine the effectiveness of emotion recognition interventions in high-risk children before the onset of a criminal career and study how improved emotion recognition causes a reduction in crime.

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