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

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

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

**A case for emotion recognition**

*Why is emotion recognition important?*

Being able to detect, process and respond appropriately to the emotions of others is crucial for normal social interaction (Corden, Critchley, Skuse, & Dolan, 2009; Fridlund, 1991). Interpreting another’s facial displays of emotion provides insight into their thoughts, beliefs, and intentions and allows one to explain and interpret their behaviour. An aptitude
in emotion recognition helps to initiate and maintain healthy social relationships and to participate successfully in a range of life activities and social situations (Izard et al., 2001; Leppänen & Hietanen, 2001; McClure & Nowicki, 2001). Indeed, young children who are good in recognising other people’s emotions are more socially skilled and popular (Manstead & Edwards, 1992).

How is emotion recognition learned?

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

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

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

Theories linking emotion recognition and ASB

A deficiency in understanding the emotions of others may be causally linked to ASB, as proposed by Blair’s (2005) Integrated Emotion Systems (IES) model. Accordingly, distress cues, such as fear and sadness, serve to inhibit ASB. Specifically, the correct processing of others’ distress-related cues is thought to elicit empathy that, in turn, results in learning to avoid aggressive acts that cause fear and sadness. Indeed, the inability to experience another’s distress vicariously or to empathise with another person affectively has been identified as a possible cause of ASB (Decety & Jackson, 2003). Importantly, Bons et al. (2013) showed that emotion impairments for negative emotions are specific for children with Conduct Disorder. The findings by Bowen and colleagues (2014) also support this view; because angry faces serve as warning signals of social punishment, children at risk for ASB may be less sensitive to low intensity (early warning) signals and therefore continue to behave in socially unacceptable ways. The IES theory also states that these individuals are impaired in the formation of stimulus-reinforcement associations, meaning they do not create the association between the victim’s distress, their own negative feelings and their behaviour. All of this culminates in the development and continuation of their negative behaviours (see Figure 1).
Antisocial and aggressive individuals are not only impaired in recognising negative emotional facial expressions but they have also been found to interpret benign or neutral information as hostile (Crick & Dodge, 1994; Dodge, Pettit, Bates, & Valente, 1995). They are more likely to interpret an expression of disgust as angry (Sato, Uono, Matsuura, & Toichi, 2009) and ambiguous expressions as angry (Mellentin, Dervisevic, Stenager, Pilegaard, & Kirk, 2015; Schönenberg & Jusyte, 2014). This ‘hostile attribution bias’ may lead them to be more likely to be involved in aggressive situations, thereby contributing to ASB.

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

Neurobiology of ASB and emotion recognition

The amygdala is thought to be an important area in the brain for emotion recognition. In neuropsychological studies, individuals with damage to the amygdala have been found to be less able to recognise negative facial expressions, particularly fear but also anger, disgust and sadness (Adolphs et al., 1999; Fairchild et al., 2013; Schmolck & Squire, 2001). Functional imaging studies with healthy populations have also shown an activation of the amygdala in response to fearful stimuli (Breiter et al., 1996; Morris et al., 1996; Whalen et al., 2001). This, combined with the knowledge that the amygdala is activated when individuals view negative facial expressions or pictures (Whalen et al., 2001), has led to the
belief that the amygdala is important for processing threat information. Importantly, structural scans of young people who display ASB have shown an amygdala dysfunction (Fairchild et al., 2011; Jones et al., 2009; Marsh et al., 2008; Sterzer, Stadler, Krebs, Kleinschmidt, & Poustka, 2005). Fairchild et al. (2011) showed that structural amygdala abnormalities were present in adolescents with Conduct Disorder, no matter whether their disorder was of child or adolescent onset, compared to healthy adolescents. In their meta-analysis of 20 studies, Marsh and Blair (2008) found a robust link between ASB and specific deficits in the recognition of fearful expressions, which the authors suggest is linked to this amygdala dysfunction. Evidence of this dysfunction also supports Blair’s (2005) IES model because the amygdala is thought to be involved in the formation of stimulus-reinforcement associations, thus it not only impairs the ability to recognise these distress cues but also to learn from them.

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

In a recent review, Marsh (2016) reconsidered the role of the amygdala in emotion recognition impairments, specifically in relation to fearful expressions. She posits that the amygdala’s role in directing attention to salient information does not fully explain why fearful emotion recognition deficits have also been observed in other modalities such as vocal expressions (Blair, Budhani, Colledge, & Scott, 2005) or body postures (Muñoz, 2009).

Instead an early hypothesis put forward by Adolphs and colleagues (Adolphs, Tranel, Damasio, & Damasio, 1995) provides a more thorough account of the role of the amygdala in fearful emotion recognition. Here, the amygdala is believed to be essential for linking perceptual representations of fear to internal representations of fear, via a process called emotional empathy or emotional contagion. An ability to identify and label stimuli as relating to fear is required to be able to link the external perceptual cue (the facial expression) to an internally generated representation of fear. In individuals with amygdala damage, it is thought that because they are impaired in experiencing fear (the internal representation), they struggle to label it in external cues, therefore being unable to link the external stimuli to the internal representation. The amygdala is not thought to be required for other emotions, such as disgust or anger, because it is not involved in generating internal representations for these emotions. Marsh suggests that the amygdala is essential for basic forms of empathy relating to fear. However, evidence of pervasive impairments (Bowen et al., 2014; Dawel et al., 2012) is again at odds with the theory that the amygdala is only important for recognising fearful expressions. Indeed, it will be interesting to find out whether other brain areas are involved in empathic responses to other emotions, such as sadness, and whether these areas are also impaired in individuals who struggle with emotion recognition.

Overall, it appears that the amygdala plays a key role in emotion recognition abilities, specifically expressions of fear. Although it is yet unclear exactly how it influences this important social ability, it is possible that emotion recognition training programs that improve attention to salient facial features could positively affect emotion recognition and/or empathy.
Figure 1. Schematic representation of the impact of amygdala dysfunctions on emotion recognition and the continuation of antisocial behaviour

Existing interventions are not always effective

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

Early family/parent training programmes are one type of intervention that has been used. Such programmes aim to improve the parent-child relationship and to reduce ASB by helping parents to learn how to control aggressive behaviour. Whilst some studies have shown that these programmes are effective in reducing ASB (for example, see Farrington & Welsh, 2003), other studies have shown that it is not beneficial in reducing violence (for example, see Bilukha et al., 2005). Overall, a meta-analysis found a small to moderate impact of family/parenting interventions on reducing ASB (Piquero, Farrington, Welsh, Tremblay, & Jennings, 2009). These programmes require extensive parental effort and some parents cannot or will not participate with the treatment (Kazdin, 1997; Losel & Beelmann, 2003; Webster-Stratton, Reid, & Hammond, 2001).
Research has also looked at the effectiveness of multi-systemic therapy (MST), which is an intensive family-based intervention for young people with serious ASB designed to address the multifaceted nature of ASB. It aims to identify and address the functional origins of ASB and promote prosocial behaviour. Whilst it has been shown to be an effective treatment option in some studies (for example, see Butler, Baruch, Hickey, & Fonagy, 2011), other studies have been less positive. For example, Sundell et al. (2008) showed that there was no additional benefit of MST compared to treatment-as-usual in a group of adolescents who reached the criteria for conduct disorder. Similar findings were shown by Leschied (2002) who found no evidence of treatment effects in serious young offenders following participation in a MST program.

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

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

**Emotion recognition training as a viable intervention**

Attempts to improve emotion recognition ability based on the hypothesis that impairments are due to attention dysfunctions to salient facial features have been carried out. Dadds et al. (2006) showed that directing boys with high levels of psychopathic traits to
look at the eyes significantly improved their fear recognition. Similar results have been reported with incarcerated male violent offenders when their attention was implicitly directed to salient facial features using dot-probe tasks (Schönenberg, Christian, et al., 2013). However, the longevity of this improvement in emotion recognition is unknown and any links to behaviour change were not investigated in these studies. Other research did include behavioural change measures following participation in emotion recognition training programs (see Table 1 for an overview) and have provided some evidence that emotion training is effective in young people with behavioural problems. One study (Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012) found a beneficial effect on parent and teacher reports of conduct problems (measured with a questionnaire, the Strengths and Difficulties Questionnaire; Goodman, 1997) in children with callous-unemotional traits. This is a distinctive subgroup that shows a more persistent pattern of problem behaviour reflecting a disregard for others and a lack of affect and empathy, similar to characteristics found in adult psychopathy. However, since the training involved close parent-child interactions that were not mirrored in the treatment-as-usual group, it is not known whether any benefits in training were due to improvements in relationships. Similarly, as the parents were involved in the training and the reporting on the behaviour change, it is possible that they were more positive in their evaluation of their child’s behaviour.

![Figure 2. Screenshot from the Cardiff Emotion Recognition Training (CERT) programme](image-url)
Penton-Voak et al. (2013) were successful in modifying emotional cognitive biases of angry ambiguous expressions in aggressive youths, who subsequently reported fewer self- and staff-reported aggressive incidents in the two weeks following the intervention. The addition of staff-reported behaviour in this study is particularly useful given that the accuracy and honesty of self-reported behaviour can be questioned. Nevertheless, staff could only report on behaviour during weekdays leaving the behaviour of participants in the evenings and weekends when they are away from the context of social support and more able to commit official offences, unaccounted for.

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

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

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

Emotion recognition training programs need to be offered in a tailored way so that those who need it most are receiving it. There is individual variation in emotion recognition performance, with some aggressive and antisocial individuals performing worse than others do (Bowen, Morgan, Moore, & van Goozen, 2014). This implies that the training might be more effective in those individuals who perform less well. Variation between individuals in behavioural change following participation in training programs could also be due to the influence of some moderating factors. For example, it has been hypothesised that individuals with higher levels of callousness are more likely to display impaired recognition abilities (Marsh et al., 2008) and it is possible that these individuals might benefit more from these training programs than others. As mentioned before, the early family environment plays an important role in the development of emotion recognition impairments. Children with emotional problems disproportionately come from disadvantaged and less supportive environments, and some of the characteristics of impaired emotional functioning are shared between parents and children, explaining the stability of antisocial behaviour over time (Sully, Sonuga-Barke, & Fairchild, 2015). The effectiveness of the emotion training might be greater if offered to those from affectively impoverished environments and/or whose families show similar emotion recognition deficits. In addition to personality and environmental factors, individual’s level of empathic abilities and physiological reactivity must also be considered. For example, will the training have the same effect in children who do not pay attention to the eyes compared to those who show impaired affective
Within the autism literature compensatory changes in neural activity, measured by fMRI, have been observed alongside improved recognition in those with autism trained to attend and interpret emotional faces (Bolte et al., 2006). It would be interesting to find out whether similar neural changes can be achieved in those with ASB and whether this has knock-on effects on the closely related domains of empathy and affective physiological reactivity.

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

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

Can emotion training be used as an early intervention?

Why is early intervention important?

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

Can emotion training be used as an early intervention?

Emotion recognition training represents a feasible early intervention strategy. These training programs are likely to be more effective when youths are targeted at an early sensitive period. The period between childhood and (early) adolescence is a time when children are particularly adept at specific kinds of social and emotional learning (Blakemore, 2008). Brain processes that underlie social and emotional behaviour have not yet matured, meaning there is increased capacity for learning appropriate social and emotional behaviour (Spear, 2000). It is also during childhood that children naturally learn to recognise facial expressions in others. At 5-6 years of age, children are able to recognise facial expressions of happiness and sadness at an accuracy level similar to adults, whereas the ability to recognise fear does not develop until 7-8 years of age and anger develops around 9-10 years
of age (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). Childhood therefore represents a key period in which children are particularly adept to learn how to accurately recognise emotions in other people. Intervening at this time using emotion recognition training programs could prevent a series of self-reinforcing mechanisms from becoming entrenched, preventing, or at least reducing, the development of aggressive and antisocial behaviours and potentially improving positive capabilities such as empathy and pro-social behaviours (Foster, 2010). This sensitive period provides a crucial opportunity not only to help these youths attain a more positive developmental trajectory, but also to diminish the enormous negative impact they can have on society.

**Practical implications**

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

**Concluding comments and future research**

Antisocial behaviour in children is persistent and difficult to treat. Although some behavioural interventions have been shown to be effective in milder forms of these problems, their effectiveness in more seriously disturbed children is limited. This is partly because of the fact that we lack a comprehensive understanding of the cognitive and emotional problems of these children and the (neuro-) psychological causes of these difficulties. However, one thing we do know is that antisocial individuals have clear and pervasive impairments in emotion recognition. By offering treatments (such as emotion recognition training), that are tailored to the causal processes that influence the
development, persistence and severity of aggressive behaviour, we believe that there is a better chance of achieving beneficial and longer-term change for these individuals.

The juvenile justice system is undergoing reform and the role of emotions in criminal offending is beginning to be acknowledged. The juvenile justice reform movement needs to be complemented by research that addresses fundamental questions about *earlier intervention* and examines specific *mechanisms of change* that could lead to reductions in crime. Interventions could then target the psychological processes that contribute to antisocial development in high-risk children before they start to get involved in the criminal justice system. Emotion recognition training programs represent a developmentally sensitive, practically feasible risk reduction strategy for high-risk juveniles that focusses on emotion recognition as a mechanism that can be targeted for behaviour change. We have shown that teaching antisocial adolescents to recognise emotions in others is practically feasible and has positive effects on subsequent crime levels. In this paper, we have also outlined a research agenda for future research that prioritizes more targeted approaches, which involve screening for existing neuropsychological impairments and assessment of environmental risk factors that impact on neurodevelopment in those at risk for future antisocial behaviour.
<table>
<thead>
<tr>
<th>Facial emotion training program (Reference)</th>
<th>Program description</th>
<th>Sample</th>
<th>Outcomes</th>
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<tr>
<td>Facial affect recognition training (Hubble et al., 2015)</td>
<td>Computerised program to direct attention to relevant facial features; 2-3 sessions, total training time 2 hours.</td>
<td>24 male youth offenders (Training) and 26 male youth offenders (Control) (mean age = 16 years).</td>
<td>Significant improvement in the recognition of fear, sadness, and anger; significant decrease in the severity of crimes 6 months later.</td>
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<tr>
<td>MindReading (Dadds et al., 2012)</td>
<td>Daily parent-child interactional exercises and therapist sessions with computerised MindReading program; 4 x 90 minute sessions.</td>
<td>196 clinic-referred children and adolescents (mean age = 11 years) assigned to treatment-as-usual group (n = 109) or emotion-recognition intervention (n = 87).</td>
<td>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.</td>
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<tr>
<td>Modifying hostility biases (Penton-Voak et al., 2013)</td>
<td>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.</td>
<td>46 juveniles (mean age = 13 years; control group, n = 23; training group, n = 23) with histories of frequent aggressive behaviour and/or criminal records.</td>
<td>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.</td>
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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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