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Biased facial emotion perception in mental health disorders: a possible target for psychological intervention?

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Abstract

Our perception of emotion in the faces of others affects our own behaviour and mood. Indeed, individuals with mood disorders such as depression and aggression often show biases in facial emotion perception. Here, we review recent and ongoing work that suggests biased emotional perception may be on the causal pathway of the onset and maintenance of mood disorders and hence, a potential target for intervention. Simple cognitive bias modification tasks that change perception of facial expressions of emotion have shown some promise as a therapeutic technique. We outline further directions to investigate the robustness and clinical impact of emotion bias modification in real-world settings.

Keywords: Facial expression, emotion, cognitive bias modification, intervention, mood disorders

Introduction

Interpreting social and emotional cues in others is a central skill in social cognition that affects our own behaviour and emotional states (Phillips, Drevets, Rauch, & Lane, 2003). An enormous literature has studied the perception of facial expressions with more recent, research demonstrating that perception of facial expressions can be strongly influenced by contextual (e.g., body posture, visual scene), and internal cues [e.g., mood, learning; (Aviezer, Hassin, Bentin, & Trope, 2008; Aviezer, Trope, & Todorov, 2012); for a review, (Wieser & Brosch, 2012)]. In this brief review, we will concentrate on work by ourselves and others that has identified these internal biases, which are often associated with mood disorders, as a potential intervention target in mental health disorders.

Negative biases in emotional perception are common in a range of mood disorders [e.g., anxiety (Mathews & Mackintosh, 2000) for a review, (MacLeod & Mathews, 2012), depression (Penton-Voak, Bate, Lewis, & Munafò, 2012), for a review (Bourke, Douglas, & Porter, 2010)], and conduct disorders (Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012; Penton-Voak et al., 2013; Schönenberg & Jusyte, 2014). As successful pharmacological interventions are also associated with reducing negative and increasing positive biases, it has been proposed that biased emotional processing may play a causal role in the onset and maintenance of these conditions (Harmer, Goodwin, & Cowen, 2009; Leppänen, 2006; Mathews & MacLeod, 2005; Roiser, Elliott, & Sahakian, 2012).

This proposed causal relationship between cognitive biases and mood disorders suggests that the ability to influence cognition through behavioural interventions may lead to improved mental health. As a result, several groups have adapted experimental techniques with the aim of

inducing changes in cognitive bias – known as cognitive bias modification (CBM) (Hertel &
Mathews, 2011). CBM might offer a cost-effective and accessible alternative/adjuvant treatment
to psycho- or pharmaco-therapy (Hallion & Ruscio, 2011; Yiend et al., 2014). It has been shown
to alter biases in attention that are often reported to be associated with anxiety, and has been
proposed to act as an anxiolytic 'cognitive vaccine' (Browning, Holmes, & Harmer, 2010;
Hakamata et al., 2010).

Recent attention has also focused on the possibility that biased facial emotional
recognition, a core feature of a range of mood disorders (Leppänen, 2006) and psycho-
pathologies (Dawel, O'Kearney, McKone, & Palermo, 2012), may offer another potential target
for CBM interventions. We review the possibility that biased facial emotion perception
represents a mechanism underlying mental health problems such as depression and aggression,
and therefore a cognitive vulnerability that may be modifiable via CBM.

Emotion perception in depression

Biases in facial emotional processing are associated with the development and persistence of
depression. Individuals who are depressed have been reported to be more sensitive to negative
affect (Gur et al., 1992; Leppänen, 2006), more likely to interpret ambiguous emotional stimuli
negatively (Rude, Wenzlaff, Gibbs, Vane, & Whitney, 2002), and less sensitive to positive affect
(Bourke et al., 2010; Surguladze et al., 2005; Yoon, Joormann, & Gotlib, 2009). Negativity in
emotion perception also predicts relapse in remitted patients (Bouhuys, Geerts, & Gordijn,
1999). Furthermore, depression is associated with changes in neural correlates of facial
expression processing, including exaggerated responses to negative emotional expressions in the
amygdala, ventral striatum and insula (Fu et al., 2004), and reduced responses to happy

expression in the thalamus, amygdala, hippocampus and putamen [(Fu et al., 2007; Lawrence et al., 2004); for a review, see (Leppänen, 2006)]. Of the six 'basic' emotions, recognition of sadness appears to be the only emotion that is not impaired in depression [for meta-analysis, see (Dalili, Penton-Voak, Harmer, & Munafò, 2015)]. Given that negative biases in emotion perception may increase behavioural responses that are socially inappropriate (e.g., blunted affective responses associated with low mood), this may evoke negative reactions from others, and reinforce biases in depressed individuals.

A causal role of biased emotional processing in depression is suggested by the effects of anti-depressant pharmacotherapies (e.g., selective serotonin reuptake inhibitors, SSRIs) and psychological therapies (e.g., cognitive behavioural therapy, CBT) in clinically and non-clinically depressed individuals; treatments that modify negative biases in facial emotional processing can have beneficial effects on depression (Harmer et al., 2009; Roiser et al., 2012). These changes in biases are rapidly observable – even in response to a single dose of SSRI (Warren, Pringle & Harmer, 2015, for a review). Crucially, these changes in emotional perception occur before improvement in patients' symptoms, and their magnitude predicts recovery. The success of SSRIs in treatment may be mediated, at least in part, by associated changes in social perception that facilitate changes in behaviour and allow learned states of depression to remit gradually [(Harmer et al., 2009; Roiser et al., 2012); see Figure 1A, B].
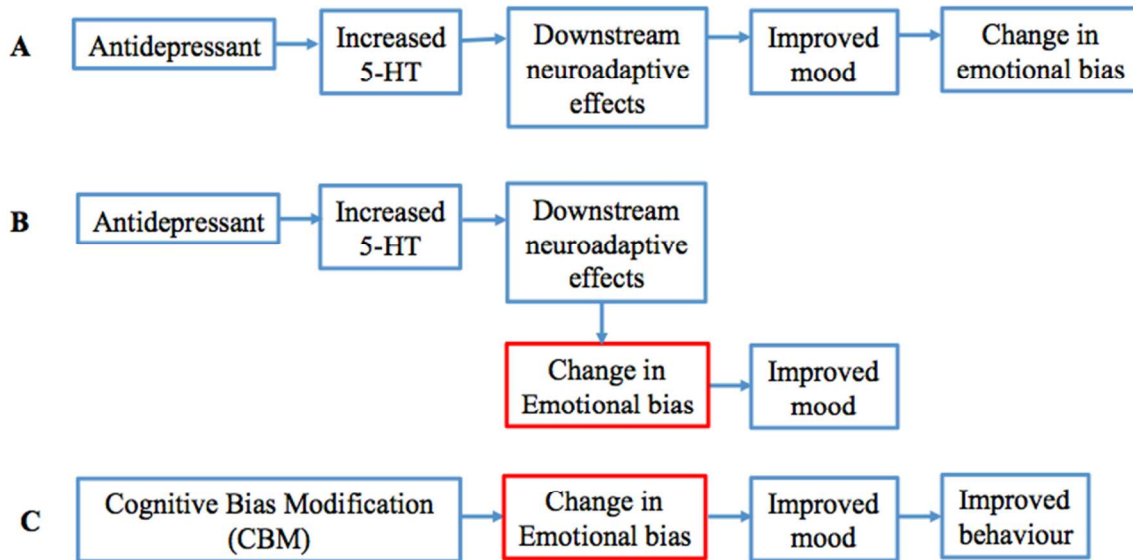
Figure 1 A) Mechanisms assumed to underlie the delay in antidepressant drug action (adapted from Harmer et al., 2009); B) Mood related effects of antidepressant action proposed to be largely mediated by changes in emotional bias (adapted from Harmer et al., 2009); and C) Targeting biased emotional perception directly using CBM could be a potential intervention (Penton-Voak et al., 2012).

The potential of directly modifying perception of facial expressions to improve mood has been shown by a double-blind, randomized controlled trial (RCT) using CBM technique (Penton-Voak et al., 2012). Young adults who reported high levels of depressive symptoms received either emotional recognition training with feedback that promoted positive bias in interpretation (i.e., designed to increase perception of ambiguous faces as happy rather than sad, Figure 2), or a control procedure that did not promote any perceptual bias.
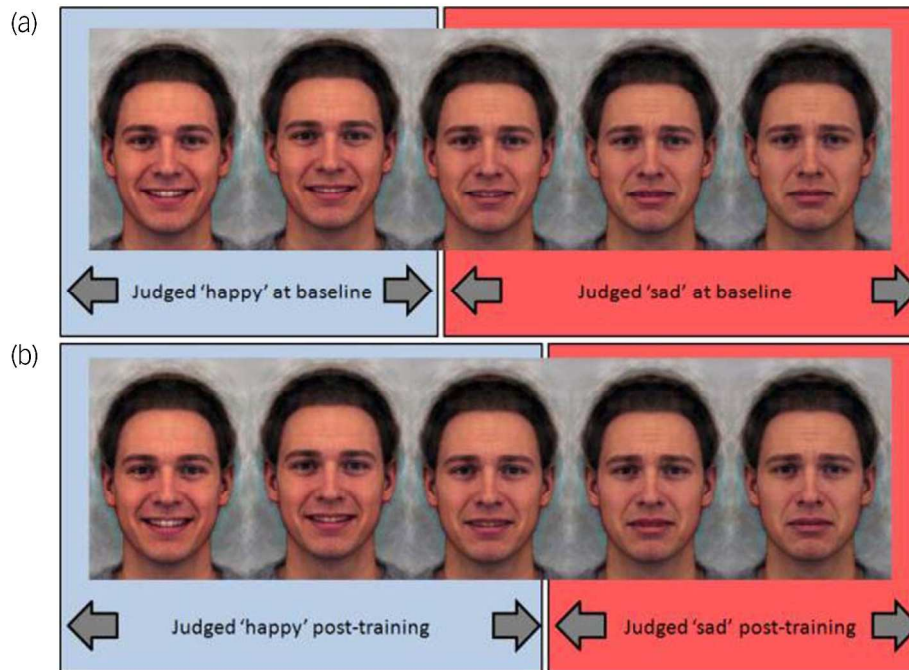
Figure 2 Schematic of participant responses to ambiguous facial expressions of emotion A) at baseline and B) after training using a CBM technique. From Penton-Voak et al (2012).

After four consecutive training sessions with feedback, those in the intervention group showed a change in their emotion categorization (biased towards seeing happy faces) and increase in self-reported positive mood two weeks after completion of training. These preliminary findings provide support for the proposed causal relationship between negativity bias in emotion perception and mood, and suggest the possibility of modifying facial emotion perception to establish a virtuous cycle of improved mood in depression (Figure 1C). Ongoing studies [e.g., (Adams, Penton-Voak, Harmer, Holmes, & Munafò, 2013)] aim to establish this behavioural effect and look at neural correlates of the CBM procedure using fMRI in young adults reporting low mood. Early analyses indicate, however, that while the neural correlates of emotion training share parallels with the effects of SSRIs, there were no effects on mood in the behavioral component of the study. Nonetheless, the demonstrated ability to modify a cognitive trait that

may be on the causal pathway of the development of mood disorders suggests that further research with clinical samples and CBM as an adjunct therapy are warranted. In particular, the effects of emotion recognition training on depressive mood over the longer term deserve further investigation, as recent studies on an attentional bias modification have shown lasting benefits up to 3-12 months (Yang, Ding, Dai, Peng, & Zhang, 2015; Yang, Zhang, Ding, & Xiao, 2016).

Emotion perception in aggressive behaviour

Negative bias in facial emotional perception is linked to the onset and maintenance of aggressive behaviours. Aggressive and anger-prone individuals tend to interpret ambiguous emotions as angry and hostile (Dodge, 1993; Mellentin, Dervisevic, Stenager, Pilegaard, & Kirk, 2015), which may in turn provoke hostile behaviour from others, sustaining negative biases, and a vicious cycle of aggressive behaviours. Deficits in emotional perception among aggressive individuals are associated with exaggerated amygdala reactivity and reduced activation of orbitofrontal cortices (OFC) to facial expressions of anger, a lack of coupling between amygdala and OFC when responding to angry faces, and a positive correlation between the extent of amygdala reactivity and aggressive behaviour (Coccaro, McCloskey, Fitzgerald, & Phan, 2007). Since impaired emotion perception (e.g., in fear and sadness) is also implicated in aggressive behaviour in conduct disorders (Fairchild, Stobbe, Van Goozen, Calder, & Goodyer, 2010; Sato, Uono, Matsuura, & Toichi, 2009), antisocial behaviours (Marsh & Blair, 2008) and psychopathy (Dadds et al., 2012; Dadds et al., 2006), it may act as an important mechanism in the development and maintenance of these behavioural problems.

Notably, earlier work has suggested that biased facial perception in conduct disorder is modifiable by training (Dadds et al., 2006; Schönenberg et al., 2014). Its potential as an

intervention target was further examined in a RCT in children with complex conduct disorders. Emotion recognition training was associated with behavioural improvements in children with high levels of callous-unemotional traits (Dadds et al., 2012), suggesting that training emotion perception may lead to reduced conduct problems across individuals with different diagnostic categories. However, the causal role of emotion perception in this study was unclear as there was no evidence for improved facial emotion recognition. A causal link was recently supported by another emotion recognition training study that trained a positive bias (i.e., happiness over anger) in youth at high risk of criminal offending (Penton-Voak et al., 2013). This study was closely related to the mood studies reported above (Adams et al., 2013; Penton-Voak et al., 2012), but the stimuli were adapted to induce positive bias towards happy over angry faces, rather than sad. Daily training over four consecutive days led to decreased anger and aggression, as well as reduced independent rating of aggressive behaviour immediately post-training and two weeks later. Effects on aggressive mood were replicated in separate studies using different training formats, that modifying facial emotion perception by any means may have positive effects on mood. These findings lend support for the causal role of facial emotion perception in anger and maintenance of aggressive behaviour. In another study, a single session of an identical emotion recognition training promoted bias towards happy over angry faces in both healthy adults and youths with disruptive mood dysregulation disorder (DMDD) (Stoddard et al., 2016). Training led to decreased self-reported irritability in DMDD, which was associated with increased activation in bilateral OFC and left amygdala [neural correlates implicated in aggression (Coccaro et al., 2007)] to subtle expressions of happiness relative to anger. These findings indicate that brief training to modify facial emotion recognition biases may lead to reductions in irritability and behavioural symptoms in DMDD through modulation of relevant brain circuitry.

Implications

There is now growing evidence that supports a causal role of biased emotion recognition in depression and conduct problems, and potentially similar relationships may also be found in other disorders. The key implication is that these biases could be modified by brief CBM training that requires minimal supervision and could be deliverable remotely via mobile technology. This has the potential to be a cost-effective, personalisable, and accessible adjuvant and/or alternative intervention (Adams et al., 2013; Yiend et al., 2014) to enhance treatment benefits or to attenuate symptom relapse post-treatment (Hollon, Stewart, & Strunk, 2006). CBM based on emotional bias treatment may have potential as a preventive treatment, especially given the effects of related attentional training techniques on symptoms of anxiety following exposure to stressors (Hallion & Ruscio, 2011). Compared to other conventional psychotherapies, CBM demands less patient commitment (i.e., time and engagement), and its ease of access may overcome the stigma associated with outpatient visits (Yiend et al., 2014). In particular, CBM may be an attractive option to those who are less accepting of pharmacotherapies (Chabrol, Teissedre, Armitage, Danel, & Walburg, 2004), do not respond well to conventional treatments (Hallion & Ruscio, 2011), and/or have limited access to psychotherapies (e.g., CBT due to shortage of skilled therapists, limited opening hours, and treatment costs) (Titov et al., 2010). Given these potentially important implications, establishing the robustness of CBM effects on mood (especially in depression) and understanding the link between a targeted perceptual bias and its associated psychological outcomes (Koster & Bernstein, 2015) are crucial.

Further directions

While CBM may offer the benefit of targeting the specific aspect of biased perception in mental health disorders more directly than non-cognitive approaches such as SSRIs, further research is needed to establish the robustness of the observed effects and their clinical impact. Mechanistic studies are needed to determine the active components of training, and how laboratory-based training generalizes to other situations within and beyond the lab environment [e.g., transfer effects beyond trained faces and expressions (Dalili, Schofield-Toloza, Munafò, & Penton-Voak, 2016; Griffiths, Jarrold, Penton-Voak, & Munafò, 2015)].

Examining the therapeutic value of CBM in sub-clinical populations may be particularly important as there exist gaps in treatment provision due to limited healthcare resources, which prioritizes more severe and urgent conditions (Jorm and Griffiths, 2005). Two studies have recently been completed to investigate the effects of emotion training. The first, in adolescents with high levels of social anxiety, suggests that while CBM did not improve the primary outcome measure of social anxiety in adolescents, there was evidence of lower self-reported depression symptoms after training, with further reduction at 2-week follow up (Clinical Trials ID: NCT02550379). A study in healthy adults (Peters et al., 2017, January 30) showed no evidence of change on the majority of cognitive and mood measures, but there was some evidence of training improving a self-report measure of stress impact and a cognitive measure of anhedonia. There was also some evidence that CBM outcomes may be influenced by the severity of trait anxiety. While this work in sub-clinical populations is important, research with clinical samples may be better positioned to assess the interaction between CBM and symptom severity (Amir, Bomyea, & Beard, 2010; Dadds et al., 2012; Dalili et al., 2015; Hallion & Ruscio, 2011).

Future research should examine whether synergistic effects of CBM and psycho- or pharmaco-therapies might be greater than these treatments alone; these interventions may act in a

complementary manner. So, while CBM targets early stage, basic, automatic biases, conventional psychotherapies may act at later stages, challenging perceptual biases using a top-down approach, (Hallion & Ruscio, 2011). Analogously, while SSRIs successfully reduce the salience of negative emotional signals in the environment (Warren, Pringle, & Harmer, 2015), emotion recognition training focuses on instilling positive biases. Preliminary evidence from the secondary outcomes in (Peters et al., 2017, January 30) indicates that CBM may have some effects on anhedonia. Given that anhedonia is linked with poorer treatment outcomes and is currently difficult to treat (Nutt et al., 2007; Vrieze et al., 2013), investigating the cognitive and neural mechanisms underlying the observed training and behavioural effects is important to understand the aetiology of these conditions, and guide the development of more targeted interventions.

Understanding the therapeutic value of CBM would require research on its dose-response (Cristea, Kok, & Cuijpers, 2015; Hallion & Ruscio, 2011) in mood disorders with different neuropharmacological origin, and in real-life settings using meaningful outcome measures (e.g., functional outcomes, quality of life measures). Larger samples are needed to reliably assess generalizability of training gains, as current studies may be underpowered to detect modest, but potentially clinically valuable behavioural improvements (Dalili et al., 2015; Penton-Voak et al., 2012). To monitor the longevity of bias modification, potential iatrogenic effects, and its interaction with real-life social interactions and stressors (Hallion & Ruscio, 2011; Penton-Voak et al., 2013), longer term studies are warranted.

Should the effects of emotional recognition training on mood prove robust, replicable and safe, the potential translation of these findings to patient benefit could be swift. The nature of CBM

makes such interventions suitable to remote delivery, and ideally suited to the recent rise of

mobile technology applications in mental healthcare (Torous & Powell, 2015) .

In sum, we are excited by recent research that has suggested a causal link between biased facial

emotion perception and mood and conduct disorders. Preliminary evidence calls for further

research to determine the therapeutic value, if any, of targeting impaired facial emotion

perception using cognitive bias modification both in the laboratory and beyond. If proven

effective, this could be a simple, affordable and accessible way to intervene with these mental

health disorders.

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