Facial expression perception: an objective outcome measure for treatment studies in mood disorders?

Helen R. Venn, Stuart Watson, Peter Gallagher and Allan H. Young
Stanley Research Centre, School of Neurology, Neurobiology and Psychiatry, University of Newcastle Upon Tyne, NE1 4LP, UK

Abstract
Facial expressions are important cues used in social communication. Studies in both patients with mood disorders and healthy volunteers have shown that facial expression perception can vary according to current mood state. Interpretation or perception of facial expressions can also be altered by administration of certain psychopharmacological agents. Novel drug development at present is restricted by the lack of valid and sensitive markers of mood state. This review suggests that measurement of facial expression perception may prove to be a useful experimental tool for assessing efficacy of antidepressant treatments.

Received 23 August 2005; Reviewed 28 December 2005; Revised 22 June 2005; Accepted 5 July 2005

Key words: Depression, drug development, emotion, facial expression, mania, neuroendocrine, phase II trials.

Introduction
The past 15 years have seen an unprecedented advance in our knowledge of the biochemical, neural, genetic, and behavioural foundations of depression and mania. There is no doubt today that depression and bipolar illness are brain disorders resulting from complex interactions between many biochemical, genetic, cognitive, behavioural, and environmental factors. This has led to the availability of a wealth of potential drug targets and hence the opportunity to accelerate the process of discovery in mood-disorder treatments towards novel treatment techniques. However, advances in depression research and treatment development are highly dependent on the quality of research methods which measure, assess or classify the pathology and its expressed symptomatology.

No reliable biological markers or valid behavioural tests exist to define the exact nature of depression and disentangle issues of co-morbid pathologies, co-occurring syndromes or clusters of symptoms; accordingly, diagnostic classification systems have principally relied upon clinical description and behavioural signs and symptoms to define the syndrome (e.g. sadness, sleep difficulties, anhedonia). Historically, diagnostic measures of depression have utilized either patient self-report of symptoms or clinician rating of patient symptoms, but these do not always correspond (e.g. Bailey and Coppan, 1976; Prusoff et al., 1972; Sayer et al., 1993) and the most widely used instruments in clinical settings have generally failed to provide a clear representation of the specific symptoms experienced by individuals and instead typically have offered only global indices of depression. The assessment of psychiatric disorders is complicated by rapid, complex clinical changes and varying trajectories of response that may not be adequately captured by conventional rating-scale scores (NIMH, 2003). Despite this, they have been widely used for multiple purposes with broad public health implications, including validating the efficacy of new medications for treatment and identifying people who might respond to various treatments for depression.

Treatment effects, although clinically relevant, are often modest and, therefore, require large samples to reach statistical significance. Placebo response can be high, thus making demonstration of efficacy difficult (Thase, 1999). As a result, definite proof-of-efficacy is rarely possible in early phases of drug development and requires relatively large phase III trials. Still, up to 50% of these studies are inconclusive and do not
show any statistically significant differences between test drug, placebo and active comparator. Failure of a compound at this stage, or the need to repeat studies, is a very costly complication. Problems with the precision in assessments could also stem from inadequate rating instruments. The primary outcome measures need to have good psychometric quality (validity, reliability, the sensitivity to detect change and the ability to discriminate between active drugs and placebo). For international trials, valid and reliable translations must be available. Rating instruments should be acceptable for the scientific community and regulatory authorities. Many of the scales that are currently used, e.g. Hamilton Rating Scale for Anxiety (HAMA; Hamilton, 1959), Hamilton Rating Scale for Depression (HAMD; Hamilton, 1960), and Montgomery–Asberg Depression Rating Scale (MADRS; Montgomery and Asberg, 1979) were developed long before the current classification systems came into use. However, these instruments are still widely used and have even attained the questionable status of a gold standard, and will probably not be replaced in the near future (Buller and Legrand, 2001).

In a recent review of the psychometric properties of the HAMD, it was found that many scale items are poor contributors to the measurement of depression severity and others have poor inter-rater and re-test reliability. It was concluded that the scale is both psychometrically and conceptually flawed and that the breadth and severity of the problems mitigate against efforts to revise the current instrument (Bagby et al., 2004).

Moreover, many of these instruments lack sensitivity to change (Baldessarini, 2003). This limits further the effect size and the power of clinical trials; it has been estimated, for instance, that randomized controlled trials comparing the efficacy of antidepressants need to enrol 300 or more patients (Thase, 2002). Valid novel outcome measures and biomarkers which are appropriate for individuals of diverse cultural backgrounds, and for individuals at various stages of development (i.e. children, adults, elderly), suitable for use in diverse settings (e.g. clinical trials based in academic centres and community-based mental health), and sensitive to individuals with various comorbid medical conditions, are urgently required for proof of concept studies of innovative compounds for the treatment of mood disorders (NIMH, 2003).

In the present paper, we suggest one such alternative approach. Recently, research in the area of facial perception (and especially, the perception of emotion) has increased and been facilitated by the development of computer software, including interactive ‘morphing’ paradigms, that allow subtle elucidation of the effects of mood state on the perception of these expressions of emotion. This has been done not only by comparing psychiatric patients and healthy control subjects and also by examining the same subject during different mood states (for example when depressed and when euthymic).

Moreover, a growing body of research suggests that some pharmacological agents affect the ability to recognize certain facial expressions/ emotions. This has implications for our understanding of the underlying neurobiology of the perception of different emotions. It also raises the exciting prospect that perception of facial expressions could be used as an outcome measure in psychopharmacological studies as a sensitive proxy for mood changes.

The present paper is not intended to be a comprehensive review of the field of emotional (facial) processing. Instead, we set out to examine and evaluate the evidence for utilizing facial perception tasks as a meaningful objective marker of mood state. We first outline the neural substrates of emotion perception for faces before reviewing the effect of various psychopharmacological agents on emotion perception (with a particular focus on those of relevance to mood disorders) and the effects of mood state on emotion perception, examining specifically the evidence from mood disorders.

Facial expressions as an important means of communicating

Perception of facial expressions provides information crucial to our understanding of the physical and social environment in which we live. Faces display information not only about identity, gender and age, but also about emotions and intentions. The ability to discriminate accurately between different facially expressed emotions is critical in the context of social behaviour; to interact successfully with others, we not only need to comprehend others’ non-verbal signals in order to predict their behaviour, but we also need to be able to express our own feelings and intentions.

On the basis of his evolutionary theory, Charles Darwin postulated that certain fundamental facial expressions of emotion have adapted for behavioural purposes and are therefore innate, automatic and universal (Darwin, 1872, republished 1965). Chimpanzees and monkeys are able to produce a range of facial expressions and recognize them in others (Parr et al., 2000), and similar positive (and negative) hedonic patterns of facial affective reaction have been found to be elicited by humans and other...
Neural substrates for perceiving emotion from faces

Perception of facial expressions is believed to occur independently from other aspects of face processing (Bruce and Young, 1986). In particular, various sources of evidence point to a neural segregation of the processing of facial identity and emotion. Electrophysiological recordings in the macaque have revealed separate populations of cells that respond to facial expressions and identity and these findings have been complemented by studies among humans using neuroimaging techniques (George et al., 1993; Sergent et al., 1994). Further support for an identity-expression dissociation comes from studies of patients with prosopagnosia, who have a selective deficit in the ability to identify faces but yet do not have any deficit in recognition of facial expressions (e.g. Hécaen and Albert, 1978; Tanel et al., 1988) and from patients whose ability to recognize faces remains intact but who display deficits in the perception of facial expression (e.g. Adolphs et al., 1994).

Interpretation of facial expressions is a highly complex process and is likely to involve multiple brain regions. In humans, visual analysis of faces is probably mediated by a core system consisting of regions in the occipitotemporal extrastriatal visual cortex. An extended system comprising areas including the amygdala, orbitofrontal cortex and prefrontal cortex is thought to act in conjunction with this core system in order to derive meaning from faces (e.g. Haxby et al., 2002; Streit et al., 1999).

Increasing evidence from neuropsychological and neuroimaging studies suggests the existence of separate neural substrates underlying the processing of at least some facial expressions. The most compelling evidence for functionally discrete processing pathways for specific emotions comes from double dissociation studies. In the field of neuropsychology, a dissociation is said to occur when a patient, or group of patients, is impaired in one task or set of tasks, but remains at least relatively unimpaired on another task or set of tasks. However, the existence of a simple dissociation may merely reflect task difficulty: a patient may perform normally on one task and be impaired in another simply because the latter is relatively harder than the former (e.g. Ellis and Young, 1995). Therefore, double dissociations are required in order to reflect a true discontinuity between modalities which are impaired and those which remain intact. In the case of facial expression perception, therefore, the most persuasive evidence for functionally discrete processing pathways for specific emotions comes from such studies. Robust support has already been found for a double dissociation between fear (Adolphs et al., 1994; Broks et al., 1998; Calder et al., 1996) and disgust (Gray et al., 1997; Sprengelmeyer et al., 1996, 1997a), while functional imaging and lesion studies have also shed light on the particular neural substrates involved in the processing of some of the other basic emotions. Examples of some of these are presented subsequently.

Fear

Impairments in the ability to recognize fear have been found among patients with lesions to the amygdala (Adolphs et al., 1994; Broks et al., 1998; Calder et al., 1996). Lesion studies have been supported by functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) studies, which have consistently reported increased activation in the amygdala upon presentation of fearful expressions (e.g. Breiter et al., 1996; Phillips et al., 1997, 1998). Furthermore, the degree of increased activity has been shown to be positively correlated with the intensity of emotion presented (Morris et al., 1996). Enhanced amygdala activity has also been shown following rapidly presented masked fearful faces (Morris et al., 1997; Whalen et al., 1998), suggesting that the amygdala is responsive to expressions of fear even when the stimuli are not consciously perceived.

Some evidence also exists for a neural system for recognizing expressions of fear from multiple modalities. Scott et al. (1997) have reported impaired auditory recognition of fear in a subject with extensive...
amygdaloid damage, while Phillips et al. (1998) have found amygdala activity to increase in response to vocally expressed fear among healthy volunteers using an fMRI paradigm.

**Disgust**

Recognition of disgust has been found to be impaired in both patients with Huntington's disease (Sprengelmeyer et al., 1996, 1997a) and in pre-symptomatic Huntington's gene carriers (Gray et al., 1997). These findings strongly implicate the basal ganglia, one of the first brain regions to be affected in Huntington's disease. fMRI studies among healthy subjects have revealed activation of both the basal ganglia and anterior insula upon presentation of disgusted compared to fearful or neutral expressions (Phillips et al., 1997, 1998; Sprengelmeyer et al., 1998). Intense expressions of disgust have also been found to activate structures linked to the limbic cortico-striatal-thalamic circuit in healthy volunteers (Phillips et al., 1997). Further support for the role of limbic and prefrontal areas comes from observations of impaired ability to identify disgust among patients suffering from obsessive-compulsive disorder (Sprengelmeyer et al., 1997b), a condition in which limbic and frontal-striatal pathology is recognized (e.g. Alarcon et al., 1994).

In their study of patients with Huntington's disease, Sprengelmeyer et al. (1996) reported selective impairments in the recognition of vocally expressed disgust in addition to those found for facial expressions of disgust. Similarly, Calder et al. (2000) have found specific impairments in recognition of both visual and auditory disgust in a patient with brain damage to areas that included the putamen and the posterior part of the anterior insula. Interestingly, the patient in Calder et al.'s study also showed impaired experience of disgust, as ascertained from a reaction questionnaire. These findings are therefore consistent with the existence of a multi-modal system for recognizing expressions of disgust in others.

**Anger**

PET studies among healthy volunteers have implicated the orbitofrontal and anterior cingulate cortices in the processing of anger, with the amount of activity in the orbitofrontal cortex correlating with intensity of expression stimuli (Blair et al., 1999). Consistent with this neuroimaging data implicating the anterior cingulate, Harmer et al. (2001a) found that transcranial magnetic stimulation (TMS) over the medial frontal cortex impaired the processing of anger. Healthy subjects were presented with computerized morphed images of angry, happy and neutral faces, displayed at a range of emotional intensities (from 0% and 100% in 10% steps) for 200 ms. They were asked to classify each expression presented as quickly and accurately as possible. Subjects receiving TMS were found to be relatively slower at recognizing angry expressions compared to happy and neutral expressions. Co-occurrence of facial and auditory expression deficits has also been shown for anger in a patient with damage to the amygdala (Scott et al., 1997).

**Sadness**

PET studies among healthy volunteers have revealed enhanced activation in the left amygdala that correlates with intensity of sad expressions presented (Blair et al., 1999; Schneider et al., 1995). Tentative support for the role of the amygdala in the processing of sadness also comes from studies of psychopathic individuals. Psychopathy has been tentatively associated with amygdala dysfunction (Blair et al., 1999; Patrick, 1994), with psychopathic patients displaying attenuated startle reflexes and electrodermal activity following exposure to unpleasant stimuli and deficits in aversive conditioning similar to those observed among patients with amygdaloid lesions (e.g. Aniskiewicz, 1979; Bechara et al., 1995; Patrick et al., 1993; Patrick, 1994). Furthermore, psychopathic individuals appear to be hyposensitive to expressions of distress in others; for example they have been found to elicit abnormally low autonomic responses to stimuli that signal anguish, such as a picture of a crying face (e.g. Blair et al., 1997; House and Milligan, 1976).

**Summary**

Increasing evidence points to anatomically discrete neural substrates underlying at least some of the various emotions experienced by humans. Within this, there is some evidence for co-occurrence of facial emotion and emotion from other modalities, as well as experience of emotion. It does, however, appear likely that dissociable expression-processing systems are, at least to some extent, interlocking, in the sense that some emotions appear to produce conjoint neural activation (e.g. Blair et al., 1999; Phillips et al., 1998). It is, therefore, possible that a multi-stage process exists, based in part on emotion-specific separable neural pathways working in parallel and in part on neural structures that different emotions have in common (Sprengelmeyer et al., 1998). (For a detailed discussion and review see Phillips et al. 2003a,b).
One important caveat should, however, be noted when directly comparing neuroimaging studies in this manner. Studies investigating single emotions may not be directly comparable as are, for example, those that utilize paradigms that measure responses to all six ‘basic’ emotions.

The effect of psychopharmacological agents on emotion perception (see Table 1)

Accumulating evidence suggests that the perception of at least some facial expressions can be altered by certain psychopharmacological agents. Most interestingly, dissociations with respect to some emotions have clearly been demonstrated in this context.

Serotonin (5-HT)

Using a computerized task in which facial expressions of five basic emotions (happiness, sadness, fear, anger and disgust, but not surprise) were displayed having been ‘morphed’ between neutral (0%) and each emotional standard (100%) in 10% steps, Harmer et al. (2003b) found evidence for an effect of the neurotransmitter 5-HT on facial expression perception. Specifically, administration of a SSRI significantly facilitated recognition of fearful and happy faces compared to placebo, both in terms of accuracy of emotion recognition and speed of classification. Differential effects are, however, found in subjects with a history of depression as Bhagwagar et al. (2004) reported that subjects with a previous history of depression showed a selectively greater recognition of fear relative to controls which was normalized following citalopram infusion, an effect that was opposite to that seen in their controls.

Further support for an effect of the 5-HT systems on perception of fear comes from the study by Attenburrow et al. (2003) which found increased fear recognition following acute administration of nutritionally sourced tryptophan (Trp), a precursor to 5-HT, as well as a trend for increased recognition of happiness. This corroborates Harmer et al.’s (2003c) finding of decreased recognition of fear following a reduction in plasma Trp through acute dietary Trp depletion. Interestingly, a clear double dissociation has been demonstrated recently using low-dose acute tryptophan depletion (ATD) in recovered depressed patients and healthy controls (Hayward et al., 2005). ATD specifically decreased the recognition of happy facial expressions in the recovered depressed group, whereas the opposite effect – increased happiness recognition – was found in the healthy control subjects. There was also an overall group difference for the recognition of disgust, with the recovered depressed group showing enhanced recognition relative to the healthy control subjects.

It is plausible that these effects may be mediated by the neural structures responsible for perception of emotions. Sheline et al. (2001) presented masked expression images to depressed patients and controls before and after treatment with the SSRI sertraline. fMRI during the task showed hyperarousal in the left amygdala for all presented emotions (greatest for fear) among the depressed group relative to controls. Following antidepressant treatment, however, the results showed normalization of bilateral amygdala activity to all expressions among the patients (and no difference between conditions for the controls). Therefore, the increased amygdala activation that accompanied depression appeared to be normalized by successful antidepressant treatment.

The genetic component must also be considered in this respect. Recent work by Hariri and colleagues has found 5-HTTLPR short allele-driven (a variant in the human serotonin transporter gene – SLC6A4) hyper-reactivity of the amygdala in a large cohort of healthy subjects with no history of psychiatric illness (Hariri et al., 2005). Interestingly, previous work by the same group reported that individuals with one or two copies of the short allele exhibit greater amygdala neuronal activity in response to fearful stimuli (Hariri et al., 2002). This may suggest that genetically driven variations of brain regions involved in emotional processing, which may be trait markers of – or vulnerability to – mood disorder, could in future be assessed through behavioural and/or neural responses to emotional stimuli.

Noradrenaline

A number of recent studies suggest that other neurotransmitter systems may also affect the evaluation of certain facial expressions. For example, Harmer et al. (2003a) found that reboxetine, a noradrenergic antidepressant, selectively increased recognition of happy expressions among healthy volunteers, accompanied by a facilitation in the recognition of positive vs. negative emotions in an emotional categorization task. These effects occurred in the absence of any global effect on speed, memory or attention, or in subjective mood ratings, thereby implying a selective increase in the processing of positively valenced emotional material. Harmer et al. (2004) also found chronic (7-d) administration of reboxetine resulted in selective reduction in the recognition of the negative emotions fear and anger. Further support for a role of
<table>
<thead>
<tr>
<th>Study</th>
<th>Groups</th>
<th>Age/sex (F: M)</th>
<th>Study design</th>
<th>Drug/dose</th>
<th>Target system</th>
<th>Task used</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhagwagar et al. (2004)</td>
<td>20 euthymic patients with history of at least 2 depression episodes</td>
<td>Patients: F: M = 20:0 Mean age 36.0 yr Controls: F: M = 20:0 Mean age 38.7 yr</td>
<td>Double-blind, randomized, between groups design</td>
<td>Citalopram 10 mg (i.v.) or placebo, for both groups</td>
<td>Serotonergic</td>
<td>210 computerized faces (0–100% emotional intensity). Subjects to choose from happiness, fear, anger, sadness or disgust as quickly as possible</td>
<td>Increased recognition of fear in patients relative to controls, which was normalized by citalopram infusion</td>
</tr>
<tr>
<td>Attenburrow et al. (2003)</td>
<td>24 healthy volunteers F: M = 24:0 Mean age 26.3 yr</td>
<td>Double-blind, randomized, parallel groups design</td>
<td>Nutrionally sourced tryptophan (Trp) 1.8 g or placebo</td>
<td>Serotonergic</td>
<td>250 computerised faces (0–100% emotional intensity). Subjects to choose from list of 6 basic emotions plus neutral as quickly as possible</td>
<td>Trp selectively enhanced recognition of fear and happiness compared to placebo</td>
<td></td>
</tr>
<tr>
<td>Harmer et al. (2003b)</td>
<td>24 healthy volunteers F: M = 24:0 Mean age 38.7 yr</td>
<td>Double-blind, randomized, between groups design</td>
<td>Citalopram 10 mg (i.v.) or placebo</td>
<td>Serotonergic</td>
<td>210 computerized faces (0–100% emotional intensity). Subjects to choose from happiness, fear, anger, sadness or disgust as quickly as possible</td>
<td>Citalopram selectively increased recognition of fear and happiness compared to placebo</td>
<td></td>
</tr>
<tr>
<td>Hayward et al. (2005)</td>
<td>24 recovered depressives 24 healthy volunteers</td>
<td>Double-blind, randomized, between groups design</td>
<td>Trp-depleting mixture or placebo (containing 2 g Trp)</td>
<td>Serotonergic</td>
<td>250 computerized faces (0–100% emotional intensity). Subjects to choose from list of 6 basic emotions plus neutral as quickly as possible</td>
<td>Trp depletion selectively decreased recognition of happiness in patients but increased recognition of happiness in controls. Overall increased recognition of disgust among patients compared to controls</td>
<td></td>
</tr>
<tr>
<td>Sheline et al. (2001)</td>
<td>11 depressed patients 11 healthy controls</td>
<td>Patients: F: M = 6:5 Mean age 40.3 yr Controls: F: M = 6:5 Mean age 39.8 yr</td>
<td>Between groups design</td>
<td>Patients administered sertraline (average ~100 mg) (taken for 8 wk)</td>
<td>Serotonergic</td>
<td>fMRI, masked fearful, happy or neutral faces, interspersed with presentation of neutral faces</td>
<td>After treatment, bilateral reduced amygdala activation to masked fearful faces and all faces</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Design</td>
<td>Medication/Treatment</td>
<td>Outcome Measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
<td>-------------------------------</td>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmer et al. (2003a)</td>
<td>24 healthy</td>
<td>Double-blind, randomized</td>
<td>Reboxetine 4 mg or</td>
<td>40 examples of morphed facial expressions of 6 basic emotions. Subjects to match</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>between groups design</td>
<td>placebo</td>
<td>each with labelled keys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 12:12</td>
<td></td>
<td>Noradrenergic</td>
<td>250 computerized faces (0–100% emotional intensity). Subjects to choose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age range</td>
<td></td>
<td></td>
<td>from list of 6 basic emotions plus neutral as quickly as possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20–47 yr (mean unknown)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmer et al. (2001b)</td>
<td>20 healthy</td>
<td>Double-blind, independent</td>
<td>Propranolol 80 mg or</td>
<td>250 computerized faces (0–100% emotional intensity). Subjects to choose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>groups, randomized design</td>
<td>placebo</td>
<td>from list of 6 basic emotions plus neutral as quickly as possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 10:10</td>
<td></td>
<td>Noradrenergic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.0 yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmer et al. (2004)</td>
<td>42 healthy</td>
<td>Double-blind, between groups</td>
<td>Citalopram 20 mg,</td>
<td>Citalopram and reboxetine selectively reduced recognition of fear and anger.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>randomized design</td>
<td>reboxetine 8 mg or</td>
<td>Citalopram additionally reduced recognition of disgust and surprise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 21:21</td>
<td></td>
<td>placebo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean age</td>
<td></td>
<td>GABAergic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.97 yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blair and Curran (1999)</td>
<td>32 healthy</td>
<td>Double-blind, independent</td>
<td>Diazepam 15 mg or</td>
<td>Diazepam selectively impaired recognition of anger compared to placebo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>groups, randomized design</td>
<td>placebo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 14:18</td>
<td></td>
<td>GABAergic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.4 yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zangara et al. (2002)</td>
<td>45 healthy</td>
<td>Double-blind, independent</td>
<td>Diazepam 15 mg,</td>
<td>Diazepam selectively impaired recognition of anger and fear compared to placebo.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>groups, randomized design</td>
<td>metoprolol 50 mg or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 22:23</td>
<td></td>
<td>placebo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean age</td>
<td></td>
<td>GABAergic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.8 yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrill et al. (1987)</td>
<td>60 healthy</td>
<td>Independent, randomized</td>
<td>‘High alcohol’ (2.5 ml vodka/kg body weight) ‘Low alcohol’ (1 ml vodka/kg body weight) – both diluted with ginger ale and peppermint, or placebo drink</td>
<td>Subjects in high alcohol condition made more errors and those in low alcohol condition made fewer errors than those in placebo condition. Alcohol had selective effects on judgements of anger and disgust/contempt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>volunteers</td>
<td>design</td>
<td>GABAergic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F:M = 30:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18–28 yr (mean unknown)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Facial expression perception: a new outcome measure?
noradrenaline on the perception of facial affect comes from a previous study by Harmer et al. (2001b), in which administration of the β-adrenoceptor blocker propranolol led to a selective increased reaction time for recognition of sadness. Noradrenergic processes are already believed to be involved in recall of emotional material from long-term memory (Cahill et al., 1994), consistent with a role of noradrenaline in the processing of emotion from faces.

**Gamma-aminobutyric acid (GABA)**

There is some evidence for an effect of GABA compounds on expression perception, with administration of diazepam (a GABA agonist) associated with selective impairment of anger (Blair and Curran, 1999; Zangara et al., 2002) and fear (Zangara et al., 2002) in healthy volunteers. Further support for an effect of GABAergic compounds on the perception of anger comes from a study by Borrill et al. (1987) in which alcohol, also a GABA agonist, was associated with a deficit in the recognition of anger.

**Summary**

In summary, recent studies have provided evidence that the processing of facial expressions may be altered by serotonergic, noradrenergic and GABAergic compounds. This, therefore, supports the existence of perceptual systems underlying at least some basic emotions that are not only dissociable neuroanatomically but also neurochemically. This has significant implications in terms of our understanding of both the neurobiology of mood disorders, and the mechanisms of action of psychotherapeutic drugs on these disorders.

**The effect of mood on facial expression perception: evidence from mood disorders (see Table 2)**

A substantial body of literature spanning two decades has considered the effects of mood on expression perception. The majority of this research has been conducted among depressed patients, and a number of studies have now provided evidence for altered expression perception in these patients. In the last few years, investigators have also begun to consider the effects of manic, or elated, mood on the perception of facial expressions.

**Depression**

Some studies have reported a generalized deficit in the perception of facial expressions among depressed patients (Feinberg et al., 1986; Persad and Polivy, 1993). However, it is possible that these findings might be accounted for by selective impairments in the ability to recognize certain emotions. For example, Rubinow and Post (1992) discovered specific deficits for discriminating interested and sad faces among depressed patients.

Alternatively, deficits in facial expression perception might be accounted for by negative biases in overall judgement of facial emotion. Biases in expression perception have been reported by a number of researchers using static facial images, for example, Gur et al. (1992). Other researchers have found that depressed patients are most sensitive to sadness and least sensitive to happiness, and label any unidentified emotion as sadness (Mandal and Bhattacharya, 1985; Mandal and Palchoudhury, 1985), and that depressive are more consistent in their evaluations of sad expressions compared to pleasant expressions (Mandal, 1987). Zuroff and Colussy (1986) failed to find any evidence of a negative bias in depression, but instead reported a failure to recognize positive emotions among depressed patients. It is also important to note the caveat that these biases may extend beyond facial expressions. For example, depressed subjects have been shown to exhibit decreased brain event-related potential (ERP) responses to positive relative to negative or neutral verbal stimuli. This again may be indicative of a cognitive impairment that stems from diminished brain responses during the processing of positive information rather than an augmented response to negative (Shestyuk et al., 2005).

A bias in the judgement of facial expressions has also been found using schematic facial images. In a study by Hale et al. (1998), subjects were presented with a set of line-drawings of faces, whose emotional content depended on the combination of mouth and eyebrow types. Some of the faces were ambiguous in terms of emotion portrayed and some were unambiguous, and the subjects were required to rate the faces on a 5-point scale as to their applicability in relation to a number of facial expressions. Depressed patients gave significantly lower ratings for positive emotions (happiness and invitation) than healthy controls in both clear and ambiguous facial images. A subsequent study using schematic facial images found depressed patients to rate more sadness in expressions than controls, and also noted that judgement of negative emotions among the depressed group was directly related to depression severity and persistence (Hale, 1998).

Although not all studies of facial affect perception have demonstrated significant deficits among depressed people in terms of their ability to analyse...
emotional expressions (e.g. Archer et al., 1992; Gaebel and Wölwer, 1992; Gessler et al., 1989; Walker et al., 1984), the overall impression given by the data available is that depressed mood is associated with a defect in the appreciation, recognition or discrimination of facial expressions, which is likely to be explained in terms of a negative bias. Biases in perception of facial expressions such as those reported in a number of studies are consistent with theories that posit that depression is accompanied by negatively distorted perceptions (e.g. Beck, 1967) and are reminiscent of those seen in other aspects of perception such as attribution (Sweeney et al., 1986) and memory (Lloyd and Lishman, 1975; Teasdale et al., 1980).

Mania

There is some evidence, albeit to a lesser extent, that mania is also associated with biases in the perception of facial expressions. Lembke and Ketter (2002) compared groups of manic and euthymic bipolar patients with healthy control subjects and found an inverse correlation between recognition of sadness and scores on Young’s Mania Rating Scale (YMRS; Young et al., 1978), implying positive bias.

State or trait effect?

Despite growing evidence for biases in perception of facial expressions in depression and, to a lesser extent, mania, it remains unclear whether such effects are solely depression- or mania-state-dependent, or whether they reflect a persistent feature of affective disorders which could potentially be an antecedent of the illness.

Evidence for a state-dependent bias in expression perception in bipolar disorder has been found by George et al. (1998). The authors repeatedly tested a 40-yr-old ultra-rapid-cycling bipolar patient on a facial emotion task over a 2-yr period and found the patient’s level of depression on the day of testing influenced his negative bias in emotion recognition. When depressed, he was also significantly worse at facial emotion recognition than when he was euthymic. There were no differences by mood state in his performance in a control test of face age judgement. These findings suggest both an overall deficit in the perception of facial emotion, and a bias towards emotion depending on (depressed) mood. It should, however, be noted that this is a single-subject case study and the findings interpreted accordingly.

Studies in which mood has been induced are prone to placebo effects. Notwithstanding this, they have also provided evidence supporting the concept of state-dependent biases in expression perception. Using chimeric line drawings, David (1989) reported effects of both depressed and elated mood induced using music on the perception of facial expression among healthy subjects. In a subsequent study using the schematic facial images described above (Hale et al., 1998), Bouhuys and colleagues reported negative biases in perception of schematic facial images among healthy subjects in whom depressed mood had been induced using music (Bouhuys et al., 1995). Again, such biases are reminiscent of those seen in other aspects of perception following mood induction procedures. For example, Teasdale et al. (1980) induced elated or depressed mood among healthy students by asking them to read positively or negatively valenced self-referential statements respectively. The subjects then recalled past experiences associated with stimulus words. When feeling depressed, compared to when feeling elated, subjects were more likely to remember extremely unhappy memories, while the opposite was true for extremely happy memories. The authors suggested that these findings may, therefore, reflect an effect of mood on the accessibility of different types of cognition.

The existence of any trait-like effect on perception of facial expressions among patients with affective disorders can be further investigated by examining expression perception in these patients when remitted. Bhagwagar et al. (2004) found that remitted, medication-free subjects with a previous history of depression showed higher baseline levels of fear recognition (under placebo) relative to controls.

A number of investigators have undertaken such studies with euthymic bipolar patients, although they have produced mixed results. Harmer et al. (2002) have reported enhanced recognition of disgust among euthymic bipolar patients compared to matched controls. Addington and Addington (1998) found bipolar patients in remission to perform worse than controls in a task in which they were shown pairs of slides and asked to judge whether the expressions were the same or different, but as well as controls in a task where they were asked to select the appropriate label for facial expressions. These studies may have been confounded by residual mood symptoms. Venn et al. (2004) used a stringent classification of euthymia and reported no difference between euthymic bipolar and controls in terms of recognition of emotions or sensitivity to different expressions. Similarly, Lembke and Ketter (2002) did not find any difference between remitted bipolar patients and controls in terms of either overall accuracy of emotion recognition or identification of particular emotions.
Table 2. The effect of mood on facial expression perception: evidence from mood disorders

<table>
<thead>
<tr>
<th>Study</th>
<th>Groups</th>
<th>Age/sex (F: M)</th>
<th>Severity (by illness)</th>
<th>Task used</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feinberg et al. (1986)</td>
<td>20 schizophrenics: 20 depressed, 20 healthy controls</td>
<td>Schizophrenic: F:M = 9:11 Mean age 37.1 yr Depressed: F:M = 9:11 Mean age 26.8 yr Controls: F:M = 9:11 Mean age 29.8 yr</td>
<td>All patients hospitalized. Severity not known</td>
<td>21 photographs of 6 basic emotions. Emotion-matching (42 pairs of slides) and emotion-labelling tasks (21 trials, forced choice for 6 basic emotions plus neutral)</td>
<td>Depressed group performed worse than controls at emotional labelling but not emotion matching</td>
</tr>
<tr>
<td>Persad and Polivy (1993)</td>
<td>16 depressed students, 16 non-depressed students 16 MDD, 11 psychiatric in-patients without MDD</td>
<td>All female, 18–53 yr</td>
<td>Depressed students: BDI 16.19, non-depressed 3.75 Depressed MDD: BDI 37.06, non-depressed patients 12.82</td>
<td>Facial affect booklet of the 7 primary emotions. Questionnaire booklet on each of these</td>
<td>Overall, both depressed groups worse than healthy controls. Reported ‘less comfort’ with all emotions, except happy</td>
</tr>
<tr>
<td>Rubinow and Post (1992)</td>
<td>17 in-patients 31 healthy controls</td>
<td>Patients: F:M = 15:2 Mean age 39.0 yr Controls: F:M = 20:11 Mean age 31.0 yr</td>
<td>All patients hospitalized with bipolar or unipolar disorder and at least moderately depressed (Bunney–Hamburg Depression score ≥7)</td>
<td>Forced-choice matching of 48 facial photographs with one of seven photographs most closely expressing the same affect, for 6 basic emotions plus interest/attention</td>
<td>Patients overall worse at affect recognition and specifically made fewer correct matches for sad and interested faces</td>
</tr>
<tr>
<td>Gur et al. (1992)</td>
<td>14 depressed 14 healthy controls</td>
<td>Depressed: F:M = 12:2 Mean age 44.5 yr Controls: F:M = 12:2 Mean age 36.6 yr (range 20–73)</td>
<td>Bipolar depressed or major depression, 9 in-patient and 5 outpatient. Mean HRSD score 25.5 (range 18–35)</td>
<td>Photographs of faces expressing degrees of happy, sad or neutral emotion were shown on slides for 7 s each over 10 min. Subject required to rate each on 7-point scale from very happy, through neutral, to very sad.</td>
<td>Depressed patients more likely than controls to misinterpret happy and sad expressions. In particular they misinterpreted neutral faces as sad and happy faces as neutral.</td>
</tr>
<tr>
<td>Mandal and Bhattacharya (1985)</td>
<td>25 depressed ‘anxiety neurosis’ 25 controls</td>
<td>Depressed: F:M = 10:15 Mean age 26.4 yr Anxiety: F:M = 13:12 Mean age 22.6 yr Controls: F:M = 11:14 Mean age 25.3 yr</td>
<td>?</td>
<td>Life-size photographs of happy, sad, fear, anger, surprise and disgust. Judged the affect. One week later, repeated using only the eyebrows and eyes (middle portion) of the faces</td>
<td>Depressed patients recognized sadness most correctly either from full or middle portions of the face</td>
</tr>
<tr>
<td>Mandal and Palchoudhury (1985)</td>
<td>30 depressed 30 healthy controls</td>
<td>Depressed: F:M = 12:18 Mean age 30.4 yr Controls: F:M = 15:15 Mean age 32.0 yr</td>
<td>DSM-confirmed recurrent MDD</td>
<td>Recognition and verbosity (number of words uttered) to 3 facial affects (happy, sad, fear) in red or blue colours</td>
<td>Depressed not impaired in their recognition of sadness, but worse with happy and fear</td>
</tr>
</tbody>
</table>
Mandal (1987) 48 schizophrenic
40 depressed
50 controls
Schizophrenic: F:M = 20:28
Mean age 26.5 yr
Depressed: F:M = 18:22
Mean age 29 yr
Controls: F:M = 20:30
Mean age 24.6 yr
All patients had more than one severe episode during the last 12 months
24 photographs showing 6 basic emotions on slides. (i) Subject to label each using forced-choice paradigm; (ii) Subject to order 5 photographs of each emotion by degree of expressiveness
Depressed patients less accurate than controls at emotion recognition and rated sadness more consistently than controls

Zuroff and Colussy (1986) 14 schizophrenic
15 depressed patients
15 healthy controls
Not given
BDI scores in moderate or severe range for depressed group. Clients with MDD, dysthymic disorder or adjustment disorder with depressed mood
21 photographs, showing 6 basic emotion plus shame and interest. Subjects label each using forced-choice paradigm
Depressed group worse at overall emotion recognition than controls. More likely than controls to mis-classify ‘positive’ or ‘neutral’ expressions, but not ‘negative’ ones

Hale et al. (1998) 48 depressed outpatients
47 healthy controls
Depressed: F:M = 32:16
Mean age 38 yr
Controls: F:M = 31:16
Mean age 41 yr
BDI score of at least 17 for patients
Subject to judge 12 schematic facial images (Bouhuys et al., 1995) on how strongly they displayed each of 7 labels (sadness, anger, disgust, fear, rejection, invitation, happiness)
Positive correlation between judgement of negative emotions and depression severity at and persistence. Patients judged more sadness in faces than controls

Hale (1998) 20 depressed outpatients (plus partners)
21 healthy controls
Depressed: F:M = 11:9
Mean age 41 yr (range 22–62)
Controls: F:M = 9:10
Mean age 40 yr (range 21–59)
BDI score of at least 17
Subject to judge 12 schematic facial images (Bouhuys et al., 1995) on how strongly they displayed each of 7 labels (sadness, anger, disgust, fear, rejection, invitation, happiness)
Patients judged less positive emotions than controls

Archer et al. (1992) 12 schizophrenic
12 depressed
12 healthy controls
Schizophrenic: F:M = 9:3
Mean age 43.52 yr
Depressed: F:M = 9:3
Mean age 56.19 yr
Controls: F:M = 6:6
Mean age 48.04 yr
Clinical sample all in-patients. Severity not known
60 pairs of photographs of emotions. Subject asked to point to e.g. ‘which is happy?’ for each of the 6 basic emotions
No difference between depressed patients and controls

Gaebel and Wölwer (1992) 23 schizophrenics
21 depressives
14 healthy controls
Schizophrenic: F:M = 6:17
Mean age 31.3 yr
Depressive: F:M = 9:12
Mean age 39.0 yr
Controls: F:M = 6:9
Mean age 31.0 yr
Clinical sample all in-patients. Severity unknown
12 still videos of facial expressions. Forced choice paradigm for 6 basic emotions, plus neutral
No deficit in overall recognition of expressions in depression compared to controls

[continued overleaf]
<table>
<thead>
<tr>
<th>Study</th>
<th>Groups</th>
<th>Age/sex (F:M)</th>
<th>Severity (by illness)</th>
<th>Task used</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gessler et al.</td>
<td>60 schizophrenics (divided equally into acute, chronic or remitted)</td>
<td>Schizophrenic: F:M = 23:37; Mean age 36.3 yr</td>
<td>Severity not known</td>
<td>24 photographs to be judged in forced choice paradigm as ‘happy’ or ‘sad’</td>
<td>No difference between depressed subjects and controls on expression recognition</td>
</tr>
<tr>
<td></td>
<td>20 in-patient depressives</td>
<td>Depressed: F:M = 14:6; Mean age 43.8 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 healthy controls</td>
<td>Controls: F:M = 10:10; Mean age 29.7 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walker et al.</td>
<td>17 schizophrenics</td>
<td>Schizophrenic: F:M = 8:9; Mean age 33.0 yr</td>
<td>Severity unknown</td>
<td>1. 16 pairs of photographs showing 6 basic emotions.</td>
<td>No difference between depressed subjects and controls on emotion discrimination, labelling or multiple choice</td>
</tr>
<tr>
<td></td>
<td>14 depressed patients with affective disorders</td>
<td>Affective disorders: F:M = 8:6; Mean age 31.0 yr</td>
<td></td>
<td>Subject to identify whether same or different emotions portrayed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 healthy controls</td>
<td>Controls: F:M = 7:7; Mean age 25.0 yr</td>
<td></td>
<td>2. 16 photographs shown, forced choice paradigm for 6 basic emotions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. 16 trials of 4 photographs shown; subject to identify which depicted specific emotion</td>
<td></td>
</tr>
<tr>
<td>Lembke and Ketter</td>
<td>8 manic in-patients (bipolar I)</td>
<td>Not given</td>
<td>Mania: scores on YMRS ≥ 20</td>
<td>Forced choice labelling paradigm for 33 photographs showing 6 basic emotions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 euthymic outpatients (8 bipolar I, 8 bipolar II)</td>
<td></td>
<td>Euthymia: scores on YMRS &lt; 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 healthy controls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmer et al.</td>
<td>20 euthymic bipolar patients</td>
<td>Patients: F:M = 10:10; Mean age 37.8 yr (range 24–59)</td>
<td>HAMD score ≤ 8 YMR S ≤ 9 and euthymic for at least 6 months</td>
<td>250 computerized faces (0–100% emotional intensity). Subjects to choose from list of 6 basic emotions plus neutral as quickly as possible</td>
<td>Selective enhancement for recognition of disgust among bipolar patients</td>
</tr>
<tr>
<td></td>
<td>20 healthy volunteers</td>
<td>Controls: F:M = 7:13; Mean age 37.7 yr (range 19–62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Methodology</td>
<td>Findings</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Addington and Addington (1998)</td>
<td>49 schizophrenics, 40 bipolar patients, 40 healthy controls</td>
<td>Schizophrenics: F:M = 13:27, Mean age 32.6 yr</td>
<td>All but one (depressive-type) met criteria for bipolar disorder in remission</td>
<td>Facial affect matching – 42 pairs of slides of 6 basic emotions plus neutral – decide if same or different emotion</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bipolar patients: F:M = 30:10, Mean age 38.5 yr</td>
<td></td>
<td>Facial affect labelling – 21 trials, identify emotion from list of 7</td>
<td>Bipolar patients worse than controls overall at facial discrimination, no difference on labelling task</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controls: F:M = 17:23, Mean age 32.6 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venn et al. (2004)</td>
<td>17 euthymic bipolar patients, 17 healthy controls</td>
<td>Patients: F:M = 7:10, Mean age 44.35 yr (range 18–65)</td>
<td>HAMD score &lt;8</td>
<td>Sensitivity to emotion and accuracy of emotion recognition recorded for 6 basic emotions (0–150% emotional intensity) using interactive computer programme (36 trials)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controls: F:M = 7:10, Mean age 43.76 yr (range 21–66)</td>
<td>YMRS score &lt;8</td>
<td></td>
<td>No differences in recognition of emotion or sensitivity to any emotion between bipolar patients and controls</td>
</tr>
<tr>
<td>George et al. (1998)</td>
<td>1 ultra-rapid-cycling bipolar II patient</td>
<td>M = 1, Age 40 yr</td>
<td>When depressed Bunney–Hamburg &gt;0.6, six times when euthymic, once when hypomanic</td>
<td>Subjects to rate degree of emotion on a 7-point scale (very happy to very sad) for a series of happy, sad or neutral facial photographs</td>
<td>Patient worse at overall expression recognition when depressed compared to euthymic. When depressed also rated sad faces as more sad and misrated neutral faces as sad</td>
</tr>
<tr>
<td>David (1989)</td>
<td>12 healthy volunteers</td>
<td>F:M = 7:5, Mean age 30.9 yr</td>
<td>No history of psychiatric or neurological disorder</td>
<td>12 half-happy, half-sad line drawings, 48 stimuli. Exact mirror image for each. Forced choice paradigm for ‘happy’ or ‘sad’. Depressed and elated mood induced using music</td>
<td>Induction of depressed and elated mood led to increased choices for happy and sad emotion respectively. However, there were no significant changes in proportions of happy or sad ratings in the two mood states</td>
</tr>
<tr>
<td>Bouhuys et al. (1995)</td>
<td>30 healthy volunteers</td>
<td>F:M = 15:15, Mean age 21.7 yr (range 18–25)</td>
<td>Subject to judge 12 schematic facial images (Bouhuys et al., 1995) on how strongly they displayed each of 7 labels (sadness, anger, disgust, fear, rejection, invitation, happiness) Depressed mood induced using music</td>
<td>Degree of depression related to increase perception of rejection/sadness in ambiguous faces and less invitation/happiness in clear faces</td>
<td></td>
</tr>
</tbody>
</table>
Studies that have investigated trait-like effects of affective disorder have been largely confined to bipolar disorder (but see Bhagwagar et al., 2004), and although the results have been somewhat mixed, the majority of studies have found no evidence for an underlying trait effect on expression perception in this condition. On the other hand, the overall body of evidence suggests a state-dependent effect of both depressed and elated mood on the recognition of facial expressions.

Conclusion

Several stands of evidence converge to suggest that recognition of particular facial emotions is dependent on function of specific neural substrates and is influenced by both mood state and by psychopharmacological agents. These findings suggest that facial processing can be used as a sensitive objective marker of psychiatric morbidity. Moreover, as well as improving our understanding of neuropsychological processes, facial processing may prove to be an important tool in the examination of the efficacy and the mechanisms of action of psychopharmacological agents. Clinical rating scales such as the HAMD and YMRS have high face validity but there is a great need for new measures that are more sensitive, whilst at the same time retaining reliability and validity. Facial expression perception may be one such candidate outcome measure.

Acknowledgements

None.

Statement of Interest

None.

References


