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This Section of *Epidemiology and Psychiatric Sciences* regularly appears in each issue of the Journal to describe relevant studies investigating the relationship between neurobiology and psychosocial psychiatry in major psychoses. The aim of these Editorials is to provide a better understanding of the neural basis of psychopathology and clinical features of these disorders, in order to raise new perspectives in every-day clinical practice.

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Interaction between cognition and emotion in developmental psychopathology: the role of linguistic stimuli

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Investigations on emotional words demonstrated that processing emotional information in child patients with anxiety disorders diagnosed for anxiety (generalized anxiety disorder and post-traumatic stress disorder) or depression is biased towards pathology-related stimuli. Also, neuroimaging studies showed a failure of prefrontal areas in inhibiting the emotional reaction in children with bipolar disorder. Finally, despite several studies investigated memory and attention using emotional words, little is known about the development of emotional lexicon in both healthy and psychopathological children.

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The close interaction between emotion and cognition was suggested by behavioural and neuroimaging studies from both healthy and mentally ill individuals (e.g. Beck *et al.* 1979, 1985; Isen *et al.* 1987; Williams *et al.* 1997; Bush *et al.* 2000).

Cognitive processing of emotional material appears to be affected by pathology-coherent biases in individuals with emotional disorders (Beck *et al.* 1979, 1985; Bellani *et al.* 2011). Studies indicated that clinically depressed adults are keener on remembering negative/sad rather than positive material (e.g. Bradley *et al.* 1995), whereas anxious people show an attentional bias towards threatening stimuli (MacLeod *et al.* 1986). In addition, this bias seems to affect specific cognitive functions, but not others, in different psychiatric disorders. For instance, MacLeod *et al.* (1986) tested general anxiety disorder (GAD) and depressed adults with an emotional dot-probe detection task. The task consisted in detecting a dot that could appear in the same or different location as either an emotional threat-related or neutral word. They showed an attentional bias towards threat-related stimuli, if compared with the neutral condition, only in GAD (i.e. faster detection when the dot appeared in the same location as the threat-related word). The depressed patients, instead, attended equally to the emotional and neutral words (MacLeod *et al.* 1986). A lack of effect of negative emotional stimuli in depressed adults was confirmed in another study that used the same dot-probe

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detection task, but presented depression-related, instead of threat-related words (Gotlib *et al.* 1988). Conversely, an emotional symptom-congruent bias was found only in clinically depressed but not in GAD adults by Bradley *et al.* (1995). They showed that depressed patients freely recalled more depression-relevant than anxiety-relevant or neutral word and were faster in a lexical decision task when they had to answer to previously primed depression-relevant words.

Neuroimaging investigations in healthy volunteers suggested a parcellation of the anterior cingulate cortex (ACC) into a cognitive and emotional part that interacts through a mechanism of reciprocal suppression. In particular, cognitive demanding tasks activate the cognitive ACC part as well as a deactivation of the emotional ACC part. Conversely, emotional stimulation leads to activation of the emotional ACC and deactivation of the cognitive ACC part (see Bush *et al.* 2000 for review). In addition, a reduced activation in left ventral prefrontal cortex (PFC) was found in adults with bipolar disorder (BD) when performing an emotional-modified Stroop colour-naming task – requiring to say the colour on which a word was written while ignoring the word itself – if compared with controls (Malhi *et al.* 2005).

A pattern of cognitive biases similar to the one found in adults was revealed in children with emotional disorders. For instance, clinically depressed children recalled significantly more negative (e.g. sad) adjectives than (e.g. happy) positive, whereas the controls had comparable performances with both. Interestingly, this tendency became stronger with age in the depressed group. In addition, the same study did not find any difference between the depressed and the control groups in a recognition task (Neshat-Doost *et al.* 1998). This suggested that, similarly to adults, in paediatric depression the bias is specific to one cognitive domain, as it acts only on free later recall and not on delayed recognition of previously presented emotional material.

This result (i.e. symptom-congruent memory bias) was not replicated in a study that tested children and adolescents with depression, GAD or post traumatic stress disorder (PTSD) (Dalgleish *et al.* 2003), probably because other-referent words (e.g. sadness) and not self-referent adjectives (e.g. sad) were used. Beside memory, Dalgleish *et al.* (2003) highlighted an attention bias towards threatening stimuli specific to the anxious group (GAD and PTSD combined together), with anxious detecting faster the dot-probe when presented in the same location as a threat related word (e.g. horror). However, only the GAD showed a bias towards threat-related words, whereas PTSD had a bias away from depression-related words (i.e. they were slower in detecting the dot-probe when it appeared in the same location as the depression related word). Depressed and control children did not show any symptom-congruent attentional bias and no group reported any effect in the modified Stroop task. These results are consistent with previous investigations in both adults (Beck *et al.* 1979, 1985; also see Williams *et al.* 1997 for a review) and children (Taghavi *et al.* 1999; Bot *et al.* 2011) and favour the hypothesis that a symptom-congruent bias on attention is specific to anxiety disorder.

An attention bias towards words expressing social-treat and manic/irritable mood was reported on a sample of children of BD parents on an emotional Stroop task administered after negative mood induction (Gotlib *et al.* 2005). Also, in a functional magnetic resonance imaging (fMRI) study, negative words, relative to the neutral, elicited greater activation in the ACC and left amygdala and less activation in right rostral ventrolateral PFC and dorsolateral PFC in BD children. This favours the hypothesis that in paediatric BD there is both an enhanced reactivity in the limbic system and a reduced capacity of regulating this response by PFC when negative emotional stimuli are presented. The same pattern of activation was not found in paediatric BD for the positive words and it was not present for the healthy controls, neither in the positive condition nor in the negative condition (Pavuluri *et al.* 2008).

In summary (Table 1), cognitive functions seem to be biased in paediatric psychopathology in a way that mirrors the pattern of biases previously found in adults. The bias was revealed to be symptom-coherent and the cognitive functions involved appear to depend on the specific disorder that is taken into account. Moreover, the same neural substrates that proved to process or regulate emotional states in adults were found to have an atypical pattern of activation in children with anxiety disorders or BD. Indeed, the biases on cognitive functions are established in the early life, supported by an unusual development in some aspects of the neural substrates functionality, and more specifically in the ACC, in the limbic system and in the PFC, and are maintained throughout adulthood.

More research is needed to better define which cognitive functions suffer from emotional biases in different disorders, as well as the mechanisms through which those biases act. Moreover, despite the wide use of emotional linguistic stimuli in research on psychopathology, to date no studies investigated the development of the emotional as compared with neutral word lexicon in children with emotional disorders. Hence, we suggest that investigations on emotional

Table 1. *Summary of the results*

Study	Subjects	Subjects mean age (years)	Type of study	Tasks administered	Main findings
MacLeod *et al.* (1986)	16 GAD 16 depressed adults 16 healthy adults	32.1 43.0 36.9	Behavioural	'Emotional' dot-probe detection task	GAD only had an attentional bias towards threat-related words
Isen *et al.* (1987)	278 students	Not available	Behavioural	Candle task Remote Associates Test	Induced positive affect improves creative problem-solving performance
Gotlib *et al.* (1988)	12 depressed adults 12 healthy controls	19 19	Behavioural	'Emotional' dot-probe detection task	Depressed adults did not show an attentional bias towards depression-related words
Bradley *et al.* (1995)	17 GAD 19 depressed adults 18 healthy adults	38.1 33.3 39.6	Behavioural	Explicit memory: free recall of previously presented depression- or anxiety-relevant and neutral words. Implicit memory: lexical decision between real and unreal words using depression- or anxiety-relevant and neutral stimuli	Only depressed showed a memory bias in favour of symptoms-congruent stimuli both in the explicit and implicit memory tasks
Neshat-Doost *et al.* (1998)	19 depressed children 19 healthy children	15.43 15.35	Behavioural	Free recall for affective positive and negative and neutral words Delayed recognition of previously presented affective positive and negative and neutral words	Depressed only had a bias towards negative affective words only in the free recall condition
Taghavi *et al.* (1999)	24 GAD children 19 anxiety-depressive disorder children 24 healthy children	13.56 14.84 13.18	Behavioural	'Emotional' dot-probe detection task	GAD only had an attentional bias towards threat-related stimuli No other biases were highlighted in any group
Dalgleish *et al.* (2003)	24 GAD children 24 PTSD children 19 depressed children 24 healthy children	13.57 12.83 15.58 15.15	Behavioural	'Emotional' dot-probe detection task and emotional-modified Stroop task	GAD and PTSD only had attentional bias towards symptom-congruent stimuli in the dot-probe detection
Gotlib *et al.* (2005)	16 children of BP 10 children of not BP	Age range 9–14	Behavioural	Emotional-modified Stroop task administered after negative mood induction	Only BP offspring children had an emotional bias towards emotional negative words (social-treat and manic-irritable mood)

Continued

Table 1. *Continued*

Study	Subjects	Subjects mean age (years)	Type of study	Tasks administered	Main findings
Malhi *et al.* (2005)	12 BP adults 12 healthy adults	34.9 33.7	fMRI	Emotional-modified Stroop task	Reduced activation in left vPFC
Pavuluri *et al.* (2008)	10 PBD 10 healthy children	Age range 12–18	fMRI	Colour-word matching task	Greater activation in ACC and left amygdala, and less activation in right ventrolateral and dorsolateral PFC with negative affective words

ACC, anterior cingulate cortex; BP, bipolar disorder; GAD, general anxiety disorder; PBD, paediatric bipolar disorder; PFC, prefrontal cortex; PTSD, post traumatic stress disorder; fMRI, functional magnetic resonance; vPFC, ventral prefrontal cortex.

language should be carried out to have clearer pictures of each psychopathology and to plan effective therapeutic strategies.

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