

Activity of the behavioural activation system and the behavioural inhibition system and psychopathology

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ABSTRACT

The behavioural inhibition system (BIS) and the behavioural activation system (BAS) have been conceptualized as two neuro-behavioural systems regulating sensitivity to punishment (BIS) and sensitivity to reinforcement (BAS) and are in the basis of personality. A lack of balance in the BIS and BAS activation levels has been related to several types of psychopathology.

This article reviews the most relevant studies on the issue published over the last few years, which show that both systems prove useful to assess a number of disorders, namely eating disorders, psychopathy, alcohol dependence, personality disorders, schizophrenia, bipolar disorder and depression, and that they can be applied clinically.

Key words: behavioural inhibition system, behavioural activation system, psychopathology

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INTRODUCTION

Personality traits, from a neuro-behavioural perspective, give rise to individual differences in the activity of some brain systems. Eysenck's model of personality (1976) is the most representative one within this perspective. It is based on the identification of a series of personality traits whose dimensions are to be conceived as independent to one another and endowed with a continuous character. From a psychobiological point of view, extraversion - introversion and neuroticism - stability are the most interesting dimensions.

Eysenck relates a number of neural structures and mechanisms with the pathological differences associated with these dimensions. The degree of extraversion or introversion is determined by the reactivity of the central nervous system. The neuroticism - emotional stability dimension is linked to the brain system associated to the cortical or limbic loop responsible for connecting the brain cortex to the autonomous nervous system (Eysenck, 1967).

According to Jeffrey A. Gray (1981, 1987) emotional situations are not only characterized by the intensity of the emotional activation but also by the motivational direction that follows the behaviour depending on whether the signals are appealing or aversive. Gray's reinforcement sensitivity theory (1981, 1987) incorporates motivational issues to account for personality and remodels Eysenck's theoretical proposal.

The model postulates the existence of two fundamental dimensions, namely anxiety, which goes from the extraversion - stability pole (low anxiety) to that of extraversion - neuroticism (high anxiety), and impulsivity, which shifts from the introversion - stability pole (low impulsivity) to the one of extraversion - neuroticism (high impulsivity). The more anxiety the more sensitivity to signals of punishment, thwarted reward and novelty. Increasing impulsivity brings about a rise of sensitivity of reward and no punishment signals. Individual differences in impulsivity and anxiety can be accounted for by the action of two brain systems:

Firstly, the behavioural activation or behavioural approach system (BAS) is a positive feedback device which responds to appealing conditioned signals such as rewards or end of punishment by activating the behaviour of time and space approximation towards the positive stimulus, for which reason it can lead the organism to objectives such as food or water, etc.

BAS activity depends on structures such as dopaminergic fibres which rise from the mesencephalon or midbrain (substantia nigra and A10 nucleus from the ventral tegmental area) and innervate the base ganglia, the thalamic nucleus close to the base ganglia and the neocortical areas (motor cortex, sensory and motor cortex and prefrontal cortex) next to the base ganglia.

The BAS system consists of two interrelated subsystems, namely dorsal striated and ventral (nucleus accumbens). The activity of the BAS has been related to the development of positive affects or mood and with the impulsivity personality dimension (Corr, 2004; Gray, 1987).

Secondly, the behavioural inhibition system (BIS) is a negative feedback device which reacts against conditioned aversive stimuli and responds to signals of punishment, lack of reward or new stimuli. It works by suppressing the execution of behaviour and by increasing attention to the environment and novelty and in the

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increase in the level of arousal, in such a way that the following action, whether or not it is identical to the one interrupted by the behavioural inhibition, is carried out more vigorously and quickly. From a cognitive point of view, this system functions as a comparator, as it predicts the most likely future event and compares the prediction to the current event. The brain structures related to the BIS are the septohippocampal system, which consists of the septal area, the entorhinal cortex, the dentate gyrus, the hippocampus and the subicular area; its monoaminergic and afferent fibers and its neocortical projections to the prefrontal cortex. The performance of the BIS has been related to the development of negative affections or mood and to the anxiety personality dimension (Corr, 2004; Gray, 1987).

These original definitions of BAS and BIS postulate mutual functional independence; a later development of the theory proposes interdependence. On reformulating the theory (Gray and McNaughton, 2000), the role of the BAS remains practically unchanged. It mediates the reactions between appealing stimuli and the activation behaviour.

The fight/flight/freeze (FFF) system mediates the reactions to all aversive stimuli, both conditioned and unconditioned, and is related to avoidance and escape behaviour. The BIS role changes and becomes responsible for solving goal conflicts between BAS-activation and FFF-avoidance. Temperament and individual behavioural differences lie in the reactivity differences of these systems. High BAS reactivity is associated with focusing reward and impulsivity. People with a high reactivity to FFF show higher levels of fear and avoidance behaviour. On the other hand, high reactivity to BIS is related to a tendency to worry and to anxious brooding (Corr and McNaughton, 2008).

Subsequent theoretical development such as Cloninger's personality model (Cloninger, Svarakic and Przybeck, 1993) support a relationship between three temperament dimensions and the activity of the brain systems proposed by Gray. Cloninger's model advocates various temperament dimensions: novelty seeking, harm avoidance, reinforcement dependence, and persistence. Some of these dimensions are related to the systems proposed by Gray.

Novelty seeking, which leads to exploratory activity, is biologically related to the dopamine acting in the BAS. Harm avoidance leads to intense responses to adverse stimuli signals and stimulates the BIS through the serotonin modulating responses to novelty seeking. Reinforcement dependence is related to social reinforcement and sensitivity to social stimuli and discomfort at being outside the group. The persistence dimension leads to repeating behaviours which have been reinforced (Cloninger *et al.*).

Gray's approach to positive and negative emotions as two separate processes has been supported by rigorous psychometric approaches such as the ones carried out by Watson and Tellegen (1985).

In order to study the individual differences in BIS and BAS reactivity, self report instruments have been developed. The two most frequently used tests are *The Behavioral Inhibition/Behavioral Activation System Scales*, *BIS/BAS Scales* (Carver and White, 1994) which consists of 20 items assessing reactivity of BIS and three kinds of reactivity of BAS, namely sensitivity to reward, impulsivity and fun seeking.

The other most used instrument is *The Sensitivity to Punishment and Sensitivity to Reward Questionnaire*, SPSRQ (Torrubia, Ávila, Moltó and Caseras, 2001), which consists of 48 items, 24 of which assess sensitivity to reward as a BAS activity, and the other 24 sensitivity to punishment as a BIS activity.

Using Gray's proposal the relevance of these systems for mental disorders was put forward, they were proposed as dimensions relevant to them and it was hypothesized that extreme reactivity levels in these systems are related to psychopathology (Johnson, Turner and Iwata, 2003). The most up-to-date contributions of the model have been supported by clinical research in the expected direction, by characterizing specific neuro-behavioural system performance profiles in a number of disorders. In this way, a high reactivity of FFF is typical of phobias and panic; high BAS reactivity is usual in addictive behaviours and high BIS reactivity is found in generalized anxiety and obsessive compulsive disorder (Corr and McNaughton, 2008).

This study seeks to analyze whether the activity of the activation and inhibition behavioural systems is a relevant dimension in psychopathology. To do that, the current bibliography has been reviewed in order to describe studies on the activity of both systems in a number of psychopathological disorders and to find out whether BIS and BAS differential activation is present in them.

METHOD

A bibliographic search was carried out on *Medline* and *Psycinfo* databases, centred on the activation and inhibition systems proposed by Gray and on their relationship to a number of psychopathological disorders. Through the key expressions "behavioural activation system" and "behavioural inhibition system," their abbreviations BAS and BIS, and the words *psychopathology* and *disorder* research was selected that studied the activities of the two systems in various pathologies. The research, which had to have been carried out in the last decade, was ruled out if it had been carried out with non clinical samples. A total number of 13 works was included in our study, which followed the mentioned criteria.

DISCUSSION

Even though our research has focused on recent studies, it is worth noticing that Gray's anxiety dimension is related to the inhibition system and that BIS hyperactivity has traditionally been related to anxiety disorders (Corr and McNaughton, 2008; Gray and McNaughton, 2000). Another of the first applications of this theory has been in relation to the study of psychopathology, which have also verified that BIS hyperactivity is related to this alteration (Fowles, 1980). These studies have favoured rapprochement prior to the study of BIS and BAS activity in psychopathology.

In the review we have carried out it has been noticed that the interest in the activity of these neuro-behavioural systems in various psychopathological categories has been increasing for a few years now. Among others, a number of works dealing with BIS and BAS activity in people with eating disorders have found that patients with anorexia nervosa show hyperactivity in BIS, in contrast to healthy people. On the other hand, people with bulimia nervosa show hyperactivity both in

the inhibition system and in the behavioural activation system (Claes, Nederkoorn, Vandereycken, Guerrieri and Vertommen, 2006; Kane, Loxton, Staiger and Dawe, 2004).

A more recent study on the activity of the BIS and BAS systems in psychopathology (Newman, Mac-Coon, Vaughn and Sadeh, 2005), shows that primary psychopathology, which is characterized by a deficient affective response to others, is associated to hypoactivity of the BIS, as the first studies postulated (Fowles, 1980), whereas activity in the BAS does not show any difference from that of a control group. Secondary psychopathology, which is characterized by its ability to establish affective relationships, to feel guilt or remorse and by a high anxiety level, is only related to hyperactivity of the BAS.

As for consumption of drugs, the activity of such systems has been studied in alcoholics, who have been found to show hyperactivity in the BAS (Franken, 2002). This study also found that the greatest activity of this system is related to some aspects of craving for alcohol, as are a greater desire and reinforcement on consuming the drug.

A number of studies have also explored Gray's neuro-behavioural systems in personality disorders. One of them sought to determine whether hyperactivity in the BIS might be regarded as a vulnerability factor for Cluster C personality disorders, that is, personality disorders of avoidance, of dependence and obsessive-compulsive, irrespective of the presence or lack of anxiety and/or affective symptomatology in Axis I. It was found that high sensitivity to punishment, that is to say, hyperactive BIS, specifically differentiated between patients with Type C personality disorders and patients without any personality disorder (Caseras, Torrubia and Farré, 2001). Another study investigates the activity of the BIS and BAS in personality disorders and consumption of drugs, and finds that hypoactivity in the BIS and hyperactivity in the BAS are related both to problems due to drug abuse and to histrionic and antisocial personality disorders (Taylor, Reeves, James and Bobadilla, 2006).

Another clinical category that the construct has been applied to has been schizophrenia. It has been studied in stable schizophrenic patients taking the same medication (atypical antipsychotic drugs). They have shown only hyperactivity in the BIS in comparison to a control group of healthy people. This greater activity of the inhibition system also correlated to a longer duration of the illness (Scholten, van Honk, Aleman and Kahn, 2006)

Finally, in the group of disorders where there has been a big increase in the study of BIS and BAS activity over the last few years is in the group of mood disorders, such as bipolar disorder and depression. As for bipolar disorder, a BAS hypersensitivity model has been proposed to characterize people with this pathology. The model argues that mania, hypomania and depression episodes in these patients correspond to hyperactivity and hypoactivity in the BAS, respectively. Recent follow-up studies in bipolar and cyclothimic patients confirm this model in adult patients (Alloy *et al.*, 2008; Salavert *et al.*, 2007). Furthermore, it is evident that hyperactive BIS increases, to a large degree, the risk of major depressive episodes (Alloy *et al.*, 2008).

In patients with early onset bipolar disorder, that is, those whose disorder manifests itself in childhood and adolescence, mania and depression episodes seem to

be independent from the BAS activation level, as occurs in adults. Young patients' affective symptoms are related to hyperactivation of the BIS (Biuckians, Miklowitz and Kim, 2007).

The high co-occurrence of drug abuse has also been studied in bipolar disorders. It has been found that these patients' hyperactivity in the BAS comes from their general state and from their greater drug abuse. In consequence, it is postulated that hyperactivity in the BAS can represent a vulnerability variable in both disorders and in their co-occurrence (Alloy *et al.*, 2009).

As for unipolar depression, a number of studies show that patients with this pathology, both those affected by it while they are being assessed and those who are assessed after recovery, are characterized by a hypoactive BAS and a hyperactive BIS (Kasch, Arnow and Gotlib, 2002; Pinto-Meza *et al.*, 2006). These authors postulate that showing a hypoactive BAS after recovery might be an indicator of vulnerability to depression.

Among the limitations of this work are that some of the studies consulted do not include a contrasting control group and do not use any anxiety or impulsivity measures additional to those of BIS-BAS activity, as it has been pointed out that it is important to include anxiety and impulsivity measures when assessing them (Torrubia *et al.*, 2001) because the few measures directly developed from Gray's model do not seem to interpret the theory in the same way (Carver and White, 1994; Torrubia *et al.*, 2001).

It is also worth noticing that the databases consulted are not exhaustive and the number of published works is increasing considerably. Finally, this study cannot be regarded as a complete review of the literature but as a document which sets out the importance of the neuro-behavioural systems proposed by Gray in various psychopathological categories from a descriptive point of view.

As for the usefulness of our findings, this review allows us to see that assessing activity in the BIS and the BAS is a measure of clinical application whose psychometric assessment is very simple.

The clinical usefulness lies, first, on the fact that various constellations of the activity of both systems characterize the mental disorders discussed. Furthermore, this activity is related to a number of clinical characteristics of various disorders, such as alcoholism, schizophrenia, bipolar; with the comorbidity that arises between and among them (bipolar disorder – drug abuse, and histrionic and antisocial personality disorder – drug abuse). In some cases such activity has been proposed as a vulnerability indicator (in depression, bipolar disorder and drug abuse) and as an explanatory model of the pathology (as in the bipolar disorder and in Cluster C personality disorders).

All the studies consulted have used some of the two most frequently used measures to assess the BAS and BIS activity, so the assessment is simple, as these instruments are brief self-reported measures that increase the clinical applicability of the measures of Gray's systems.

CONCLUSIONS

If we bear in mind the goal of this study and according to the literature consulted, we can conclude that the activity of the BIS and the BAS systems is really relevant in psychopathology, it permits us to have one

measure to provide information on the clinical characteristics of various pathologies and can be applied to the various disorders studied on a daily basis.

The assessment of these systems also seems to be useful in the population at risk. Other studies which have not been addressed by this review show that the activity of these systems in a non-clinical population with dysfunctional characteristics related to the disorders discussed, such as healthy people with dysfunctional eating patterns, with subclinical symptomatology of depression and anxiety or alcohol abuse, etc, is similar to the one found in patients, which supports the clinical relevance of the BIS and BAS activity in a subclinical population.

Finally, if we bear, reformulations to Gray's theory, in mind, we believe that is appropriate to continue this line of research in order to carry out better neuro-behavioural assessment of the various types of disorders in which the BIS and BAS activity has been studied.

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