

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

7,200

Open access books available

190,000

International authors and editors

205M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Functional and Structural MRI Studies on Impulsiveness: Attention-Deficit/Hyperactive Disorder and Borderline Personality Disorders

Trevor Archer<sup>1,\*</sup> and Peter Bright<sup>2</sup>

<sup>1</sup>*Department of Psychology, University of Gothenburg, Gothenburg*

<sup>2</sup>*Department of Psychology, Anglia Ruskin University, East Road, Cambridge,*

<sup>1</sup>*Sweden*

<sup>2</sup>*UK*

## 1. Introduction

Impulsive behavior is characterized a tendency to initiate behavior without sufficient/adequate consideration of consequences. It typically refers to ill-conceived, premature or inappropriate behavior that may be self-destructive or harmful to other individuals (Chamberlain and Sahakian, 2007). Pathological impulsiveness is associated with impaired performance on neuropsychological tests of attention and executive function and with neuroimaging evidence for structural and/or functional correlates, particular in frontal lobe regions (Congdon and Canli, 2005; Crews and Boettiger, 2009; Rubia et al., 2007). Impulsive behavior is a major component of several neuropsychiatric disorders, including schizophrenia, ADHD, substance abuse, bipolar disorder, and borderline and antisocial personality disorders. The notion of impulsiveness incorporates a multidimensional construct consisting of a range of inter-related factors including novelty-seeking and reckless behavior, lack of planning ability and self-control whereby mechanistic relations evolve from its role in initiating action (Barratt and Patton, 1983; Moeller et al., 2001). The construct incorporates motor impulsiveness, inability to tolerate delays, lack of planning and an incapacity for self-control.

Impulsiveness, with or without aggressiveness, has been associated with a range of personality disorders and other psychopathologies (Haden and Shiva, 2008; Krishnan-Sarin et al., 2007; Palomo et al., 2007a; Reynolds, 2006; Shiva et al., 2009), with impulse control difficulties often of primary diagnostic importance (e.g., Pfefferbaum & Wood, 1994; Quirk and McCormick, 1998). A variety of linear regression analyses based upon several self-report questionnaire studies including a range of cognitive-emotional personal attributes have indicated that impulsiveness is predicted by negative affect, amotivation and depressiveness and counterpredicted by positive affect and internal locus of control in healthy volunteers (Palomo et al., 2008a, b; but see also Miller et al., 2009). Cyders et al. have discussed the influence of positive urgency, acting rashly under extreme positive affect, and negative urgency as central risk factors for impulsive and maladaptive behavior (see also Cyders and Smith, 2008a, b; Cyders et al., 2009, 2010; Zapolsky et al., 2009).

---

\* Corresponding Author

The inability to formulate decisions and plan actions presents a critical component of impulsiveness expressed in male offenders classified as both non-psychopathic and psychopathic (Dolan et al., 2001), euthymic and depressed bipolar patients, depressed unipolar patients and healthy controls (Peluso et al., 2007) and male forensic psychiatric in-patients facing severe criminal charges (Haden and Shiva, 2008). In a large-scale study of pathological gamblers, Ma Alvarez-Moya et al. (2010) identified four subtypes: Type I, (disorganized and emotionally unstable) showed schizotypic traits, high levels of impulsiveness, substance and alcohol abuse, and early age of onset, as well as other psychopathological disturbances; Type II (schizoid) showed high harm avoidance, social aloofness, and alcohol abuse; Type III (reward sensitive) showed high levels of sensation-seeking and impulsiveness but did not express psychopathological impairments; Type IV (high functioning) demonstrated a globally-adaptive personality profile, low levels of substance and alcohol abuse or smoking, without psychopathological disturbances but rather good general functioning. Thus, even among a broad population of pathological gamblers there exists a wide spectrum of cognitive and executive variability that requires the pathophysiological analysis of structure and function that magnetic resonance imaging may provide.

Individuals whose behavior is associated with high levels of impulsiveness frequently show general impairments over a wide range of neurocognitive tasks including tests of executive functioning (Dolan and Park, 2002; Keilp et al., 2005; Rogers, 2003), cognitive tasks demanding response control (Harrison et al., 2009; Potter and Newhouse, 2004) and cognitive flexibility [verbal fluency] (Barratt et al., 1997; Vieregge et al., 1997). The control of choice and decision-making processes seems to be modulated primarily by the eventual consequences of affective and cognitive appraisal with reinforcement/avoidance of actions directed by the underlying neural circuits (Beck et al., 2009; Frank and Claus, 2006; Koenigs and Tranel, 2007; Rustichini, 2005). Functional neuroimaging studies have implicated brain regions involved both in reinforcement and response inhibition. For example, financial rewards evoke differential patterns of recruitment in striatal and orbitofrontal cortex, as reflected in fMRI studies (Elliott and Deakin, 2005; Elliott et al., 2003). Other brain regions have been implicated in the different expressions of impulsiveness, including the inferior frontal gyrus, anterior cingulate cortex, regions of the prefrontal cortex (i.e. ventrolateral and dorsolateral), amygdala and the basal ganglia, insula and hippocampus (Love et al., 2009; Lee et al., 2009; Park et al., 2010). Gender effects have also been reported. For example, Lejuez et al. (2007) found that among 152 individuals in a residential substance-use treatment program, female subjects (37% of the sample) expressed greater use of crack/cocaine (current and lifetime heaviest) and were significantly more likely to show crack/cocaine dependence than their male counterparts. The female subjects expressed greater impulsiveness and higher levels of negative emotionality than their male counterparts, and were more likely to have suffered abuse during childhood. Impulsiveness presented a risk factor in the relationship between gender and crack/cocaine dependence and was also predictive of the quantity of drugs consumed and the duration of the dependency. These authors found no gender differences for any other forms of substance abuse (alcohol, cannabis or hallucinogens). Dysfunctional response to reinforcing stimuli, whether appetitive or aversive, appears to be a critical factor in the psychopathy of substance use and impulsiveness-related personality disorders (Petry, 2002).

Research indicates that in selecting among competing available behaviours immediate rewards are typically favoured over delayed rewards, such that with increasing delays the valuation of a future reward is reduced (known as *temporal discounting*; Ainslie, 1975).

Recent functional neuroimaging studies have explored the neural basis of temporal discounting, indicating that different (but overlapping) distributed networks are engaged as a function of the delay between decision and reward. Making choices between payoffs available at different points in time reliably engages a decision-making circuit that includes medial and/or dorsolateral prefrontal cortex (mPFC; dlPFC), posterior cingulate cortex (PCC), and ventral striatum (VS). However, evidence for specific functional roles in the decision making process across this distributed network is limited. Theoretical claims include the possibility that one or more of these regions: (1) is sensitive to the value of rewards discounted by a function of delay ('subjective value'); (2) is differentially sensitive to the availability of an immediate reward; and (3) is implicated in general/nonspecific impulsive and/or planned decision-making. Using event-related fMRI, Ballard and Knutson (2009) showed that although activation of the nucleus accumbens, mesial prefrontal cortex, and posterior cingulate cortex was correlated positively with future reward magnitude, the activation of the dorsolateral prefrontal cortex (DLPFC) and posterior parietal cortical (PCC) region was correlated negatively with future reward delay (see also Sripada et al., 2011). They found individuals expressing greater impulsiveness displayed diminished nucleus accumbens activation to the magnitude of future rewards and greater deactivations to delays of future rewards in the mesial prefrontal cortical, DLPFC, and PCC. Their observations imply that whereas the mesolimbic dopamine projection regions show greater sensitivity to the magnitude of future rewards, lateral cortical regions show greater (negative) sensitivity to the delay of future rewards, potentially reconciling different neural accounts of temporal discounting.

Motor impulsivity occurs when individuals act 'on the spur of the moment', inadequately inhibiting inappropriate response tendencies. Go/No go task performance (a measure of the ability to inhibit a prepotent response tendency) is typically impaired in neuropsychiatric patient groups for whom impulsivity is a common feature (Durstun et al., 2003, 2006; Rubia et al., 1999) whereas in healthy controls the relationship between Go/No go performance and impulsiveness is not straightforward (Helmers et al., 1995; Keilp et al., 2005). In children with attention deficit hyperactivity disorder (ADHD), fMRI studies of Go/No go task performance have shown reduced activation in the ventrolateral prefrontal cortex (VLPFC), anterior cingulate cortex, mesial prefrontal cortex and/or caudate region in comparison to age-matched normally developing controls (Casey et al., 1997; Plitzka et al., 2006; Tamm et al., 2004). Activation of the VLPFC (particularly right hemisphere) is linked to response inhibition (Aron et al., 2004). The right VLPFC and DLPFC are implicated in the relationship between response inhibition and impulsivity (Asahi et al., 2004; Horn et al., 2003; Passamonti et al., 2006). Using fMRI, Goya-Maldonado et al. (2010) examined the relationship between trait impulsivity (BIS-11) and brain activation during motor response inhibition in an uncued Go/No go task. They obtained a significant positive correlation between motor impulsivity and bilateral activation of the VLPFC, suggesting that individuals expressing high levels of motor impulsivity show stronger recruitment of the VLPFC in order to maintain task performance. In an fMRI study examining neural activation during a food specific Go/No go task in adolescent girls, Batterink et al. (2010) required subjects to inhibit prepotent responses to appetizing foods. It was found that body mass index correlated with response inhibition at both behavioural and neural levels: greater weight was positively correlated with impulsiveness and negatively correlated with activation in frontal regions associated with inhibitory control (including superior and middle frontal gyrus, VLPFC, mPFC, and orbitofrontal cortex). It should be noted also that

bulimia nervosa is associated with response inhibition deficits and higher impulsiveness (BIS-11) scores (Kemps and Wilsdon, 2010).

Comorbid aspects of clinical impulsiveness remain an issue in the pathophysiology of neuropsychiatric disorders (Palomo et al. 2007b). Both ADHD and pediatric bipolar disorder (PBD) are characterized by inattention, impulsiveness, lack of behavioural inhibition and deficits in cognitive flexibility and sustained attention (Galanter and Leibenluft, 2008; Pavuluri et al., 2006), the latter generally associated with emotional dysregulation, elated mood, irritability, increased energy and disinhibition (Pavuluri et al., 2007, 2008; Pavuluri and Passarotti, 2008). Children with PBD were found to show less activation in the VLPFC in a response inhibition stop-signal task (Leibenluft et al., 2007). In a color-naming Stroop task, PBD patients demonstrated elevated activation in the putamen and thalamus compared with healthy controls (Blumberg et al., 2003). A recent fMRI study of response inhibition in PBD patients, ADHD patients and healthy controls implicated (in the context of similarly impaired behavioral performance in both patient groups) a more focal role for VLPFC and anterior cingulate involvement in PBD (as indicated by *reduced* activation in these regions). The inhibitory impairment in ADHD was associated with more extensive prefrontal and temporal involvement. A distributed network of brain regions, within which the prefrontal cortex is of particular importance, is therefore likely to drive observed response inhibition impairments observed both in PBD and ADHD patients.

A central aspect of adaptive, as opposed to maladaptive, risky decision-making requires monitoring the value of behavioural options, possibly mediated through a 'teaching signal' expressed as a reward prediction error (PE) in the striatum. The involvement of higher level cognitive control associated with PFC might be necessary for mobilization of executive processes. Park et al. (2010) employed fMRI and a reinforcement learning task to investigate the neural mechanisms underlying maladaptive behavior in human male alcohol-dependent patients. They observed that in these patients the expression of striatal PEs was intact. Nevertheless, an abnormal functional connectivity between striatum and DLPFC predicted impairments in learning and in the magnitude of alcohol craving shown by the patients. Their findings confirm the structural abnormalities in the DLPFC that are associated with substance abuse. It is evident that frontostriatal connectivity exerts a pivotal role in the adaptive updating of action values and that impaired behavioural regulation in alcoholism may be associated with deficient interactive functionality of this system.

Definitions of impulsiveness vary from considerations of lack of persistence, patience and resistance to delayed rewards, boredom-thresholds, risk-taking behaviors and sensation-seeking behaviors to impaired understanding of the future implications of a given behavior (Barratt, 1994; Buss and Plomin, 1975; Eysenck, 1993; Logue, 1995). The intimate role of faulty timing behavior/time estimation as a non-specific factor in impulsiveness has been established in laboratory settings (cf. Evenden and Ko, 2005; Rivalan et al., 2007), with particular relevance in ADHD (Barkley et al., 1997, 2001; Meaux and Chelonis, 2003; Sonuga-Barke et al., 1992; Toplak et al., 2006). In healthy adults, the frontal cortex, basal ganglia and cerebellum are linked generally to timing functions with long or short delay intervals (Ivry and Spencer, 2004; Meck and Benson, 2002; Wiener et al., 2010). Various aspects of time processing have been addressed in individuals afflicted with ADHD, whether children/adolescents (McInerney and Kerns, 2003; Radonovitch, 2004; Smith et al., 2008) or adults (Gilden and Marusich, 2009; Marx et al., 2019; Seri et al., 2002).

Developmental trajectories of impulsive behavior bear essential outcome-expectancies for eventual disorder pathophysiology (cf. Grall-Bronnec et al., 2010). Valko et al. (2010) studied



the developmental trajectory of the time-processing deficit that has been postulated as a neuropsychological candidate endophenotype for ADHD in 33 children and 22 adults with ADHD. They found that the children and adults displayed different patterns of deficit in the discrimination of brief intervals (600 - 1,500 msec) in Go/No go and continuous performance tasks and concluded that time-processing deficits, though expressing different age-related forms, were present in adulthood. It is likely that the manifestation of the time-processing deficit in adult ADHDs may be more closely related to the fundamental processes of arousal and/or time perception with a peripheral role of executive function and response inhibition.

Recent research on the role of excessive alcohol consumption in the development of impulsive behaviors indicates that premorbid/baseline levels of impulsivity can predict the likelihood of increased impulsive behaviours following heavy drinking (White et al., 2011). This longitudinal study of boys assessed annually for 10 years until age 18 and again in their mid twenties indicated that a "moderate" (rather than "high" or "low") level of premorbid impulsiveness was the greatest risk factor for eliciting increased impulsive behaviors following heavy drinking. Basal levels of positive affect, a characteristic invariably counter-predictive for impulsiveness, appear related to outcomes of risk perception (drinking, getting into fights) in adolescents and young adults (Haase and Silbereisen, 2010). The notion of disturbed functional connectivity (see above) in frontal-striatal circuits bears consideration. Konrad et al. (2010) observed reduced fractional anisotropy (FA) and elevated mean diffusion bilaterally in orbitomedial prefrontal and right anterior cingulate cortex using voxel-based analyses in adult patients with ADHD compared with healthy controls. Impulsiveness was associated with FA in right orbitofrontal fibre tracts whereas attention was associated with DTI parameters in the right superior longitudinal fasciculus.

Rubia et al. (2009b) have argued that impulsive behavior is distinguished on the basis of a timing disturbance, with suboptimal recruitment of prefrontal, cingulate, striatal and cerebellar regions during temporal processing. They present the case that impulsiveness in ADHD is a dysfunction in temporal processing that may be reversed by acute treatment with a dopamine (DA) reuptake inhibitor. Valera et al. (2010) used fMRI to study paced and unpaced finger-tapping in a sample of 20 unmedicated adult ADHD patients and 19 healthy controls, matched for age, gender and IQ. They found that the ADHD adults expressed greater 'clock' (paced/unpaced tapping variation linked to a central clock rather than motor implementation) rather than motor variability that was consistent with a central timing locus for the atypical movements. Relative to healthy controls, the ADHD patients demonstrated reduced activity in several regions associated with sensorimotor timing, i.e. prefrontal and precentral gyri, basal ganglia, cerebellum, inferior parietal lobule, superior temporal gyri and insula. They concluded that (i) the ADHD abnormalities persisted into adulthood, and (ii) these abnormalities arose from the atypical functioning of corticocerebellar and corticostriatal timing circuits (see also Coull and Nobre, 2008; Smith et al., 2008; Terry et al., 2009).

A plethora of neuropsychological evidence indicates that abnormalities in executive functioning, particularly with regard to behavioural inhibition, are dysfunctional in ADHD (Barkley, 1997; Chamberlain et al., 2010; Lambek et al., 2011; Mattison and Mayes, 2012). Arendts et al. (2010) have presented evidence of visual cortex abnormalities in adults with ADHD, using voxel-based morphometry of high resolution MRI scans, that may be related to impairments in early-stage, "subexecutive" attentional mechanisms. Accordingly, a neurocognitive model of ADHD presents the disorder as executive dysfunction

originating from disturbances in the fronto-dorsal striatal circuit and associated dopaminergic branches (e.g. the mesocortical pathway). Nevertheless, a motivation-based account of altered reward processing, consisting of fronto-ventral striatal reward circuits and those meso-limbic branches that terminate in the ventral striatum and nucleus accumbens, implicates the avoidance of delay due to disturbances in the reward centres (Dalen et al., 2004; Sonuga-Barke, 2002, 2003; Sonuga-Barke et al., 2003). Sonuga-Barke et al. (2008) have argued that while executive dysfunction and delay aversion are implicated in ADHD neither is necessary for ADHD nor specific to the disorder. Several studies focused on the neural basis of individual differences in reward sensitivity have implicated the ventral striatum as a core component of the human reward system (Sescousse et al., 2010).

Adaptive, planned decision-making involves the selection of a particular behavior from several available options on the basis of a valuation of potential costs and benefits. Neuroimaging studies of delay and effort discounting suggest that there may be distinct valuation subsystems involved in the assessment of different types of costs (Prevost et al., 2010). The ventral striatum and the ventromedial prefrontal cortex represent the increasing subjective value of delayed rewards, whereas a distinct network comprised of the anterior cingulate cortex and the anterior insula, represent the decreasing value of an effortful option. Hahn et al. (2010) have shown that dopamine transporter variation (i.e., differences in DA availability affecting synaptic plasticity within the ventral striatum) moderates the association between ventral striatum-reactivity and trait reward sensitivity. In order to analyse further the contribution of reward processes, Carmona et al. (2009) applied a manual region-of-interest approach to assay for ventral striatum volumetric (MRIcro) alterations in 42 ADHD children/adolescents (age range: 6-18 years) compared to 42 healthy controls matched for age, gender and handedness. ADHD children/adolescents displayed marked reductions in both right and left ventro-striatal volume. Furthermore, the volume of the right ventral striatum was correlated negatively with the hyperactivity/impulsivity rating given by the mothers of the ADHD children/adolescents. Reduced volume of the ventral striatum is also associated with cognitive decline in the elderly (de Jong et al., 2012; see also Sripatha et al., 2011).

The notion that ADHD symptoms are linked to altered reinforcement sensitivity has gathered momentum (cf. Luman et al., 2010). In an fMRI study comparing neural activity within the striatum in ADHD adolescent individuals and healthy controls, Scheres et al. (2007) observed reduced ventral striatal activation during reward anticipation in the ADHD group. Consistent with other studies, ventral striatal activation was negatively correlated with parent-rated hyperactive/impulsive symptoms across the entire sample. Both frontal-striatal and fronto-cerebellar circuits, necessary for the prediction of occurrence and timing of behaviourally-relevant are also implicated in expectancy violations. For example, Durston et al. (2007) have found fMRI evidence that individuals with ADHD have diminished cerebellar activity in response to violations of stimulus timing and diminished ventral prefrontal and anterior cingulate activity to violations in stimulus timing and identity (relative to healthy age matched controls).

The dysfunctional processing of reward, in combination with a limited capacity to tolerate delay in reward, may offer an important feature of ADHD. Reinforcement Sensitivity Theory, as a conceptual notion, involves three basic brain systems: the Behavioral Approach System and the Behavioral Inhibition System (both of which activate in response to stimulus signalling events), and the fight-fright-freeze system (which responds to actual aversive stimuli; Gray, 1982; Gray and McNaughton, 2000). Gray's impulsivity notion, reflecting trait

reward sensitivity, deals with the extent to which environmental stimuli activate the Behavioral Approach System (Gray, 1991). Higher Behavioral Approach System activation due to increased trait reward sensitivity is implicated in 'disinhibitory' disorders, including ADHD and alcoholism (Franken et al., 2006; Mitchell and Nelson-Gray, 2006; Sher and Trull, 1994). Using fMRI in an appetitive task, Beaver et al. (2006) showed that the tendency to pursue Behavioral Approach System rewards was linked to a fronto-striatal-amygdala-midbrain network activation whereas Barros-Loscertales et al. (2006) describe a negative correlation between dorsal striatum/prefrontal cortex volumes and trait reward sensitivity using voxel-based morphometry. Hahn et al. (2009) studied the relationship, in 20 healthy subjects, between impulsiveness, according to Gray's notions, and event-related fMRI BOLD-response to reward anticipation in brain regions associated with reward processing. Higher trait reward sensitivity was related to cues for potential reward. Thus, the anticipation of reward during a monetary incentive delay task elicited activation in key components of the human reward circuitry, including the ventral striatum, orbitofrontal cortex and amygdala. Plichta et al. (2009) examined brain activation, with fMRI, in 14 adults with ADHD and 12 healthy controls in a task which required choosing between two monetary reward options based on immediate versus delayed reward conditions. For both immediate and delayed rewards, ADHD patients showed hyporesponsiveness of the ventral-striatum reward system compared with healthy controls. In the ADHD individuals, delayed rewards also elicited hyperresponsiveness in the dorsal caudate nucleus and the amygdala: in both structures neural activity correlated significantly with self-rated ADHD symptom severity. The authors concluded that hyperactivation, incremental along the ventral-dorsal caudate nucleus extension and amygdala, substantiates the delay aversion hypothesis. The spectre of temporal discounting (see above), in one form or another, emerges as a plausible mediating factor in the expression, both neural and functional, of impulsiveness in ADHD (see also, Rogers et al., 1999).

Given the cross-national prevalence of 3.4 % for adult ADHD (Fayyad et al., 2007), the potential and current problems associated with the disorder pose a bleak clinical reality. Functional imaging studies of children and adolescents with ADHD have implicated dysfunction of the VLPFC and DLPFC, anterior cingulate, insula, amygdala, hippocampus and ventral striatum (e.g. Amico et al., 2011; Kobel et al., 2010; Rogers et al., 1999; Sasayama et al., 2010; Sheridan et al., 2010); in adult ADHD similar regions are implicated (e.g. Depue et al., 2010a, b; Dillo et al., 2010; Schneider et al., 2010). For example, Schneider et al. (2010) observed (during a continuous performance Go/Nogo test) reduced activity in the caudate nuclei, anterior cingulate cortex and parietal cortical structures in ADHD, together with increased activity in the insular cortex, and that this was associated with the symptoms of impulsiveness and inattention. This widespread regional dysfunction was linked to symptom-profile severity in adults with a history of childhood ADHD, whether or not they qualified for a full ADHD diagnosis in adulthood. Such findings illustrate an important role for MRI in the characterization of neurodevelopmental trajectories (see also, Giedd and Rapoport, 2010; Wilens and Spencer, 2010).

Structural MRI studies indicate broad pathological heterogeneity in ADHD (e.g., Filipek et al., 1997; Mostofsky et al., 2002; Overmeyer et al., 2001; Semrud-Clikeman et al., 2006). Qiu et al. (2009) have published evidence that ADHD in boys may be associated with reduced basal ganglia volumes compared with boys with normal development. Large deformation diffeomorphic metric mapping (LDDMM) indicated that the two groups differed markedly with regard to basal ganglia morphology: bilateral volumetric compression was observed in



the caudate head and body and anterior putamen, as well as in the left anterior globus pallidus and right ventral putamen. Conversely, volumetric expansion was observed in the posterior putamen. The authors concluded that the observed deviations from normal brain development involved multiple frontal-subcortical control loops that included circuits with premotor, oculomotor and prefrontal cortex regions. The relevance of developmental trajectories in impulsive disorders was illustrated further by Christakou et al. (2010) who demonstrated that age-related reductions in choice impulsivity were associated with changes in activation in the VLPFC, ACC, ventral striatum, insula, inferior temporal gyrus and posterior parietal cortex. They indicate that the maturational pattern of functional connectivity incorporates activation-coupling between the VLPFC and DLPFC, and the parietal and insular cortices during selection between delayed options, and between the ventromedial PFC and the ventral striatum. Maturational mechanisms within limbic frontostriatal circuitry form the basis of post-pubertal reductions in impulsive choice with age increments linked to activation coherence in networks modulating inter-temporal decision-making (Christakou et al., 2010).

Borderline Personality Disorder (BPD), the most common personality disorder clinically, is characterized by severe and persistent emotional, cognitive, behavioural and interpersonal impairments (American Psychiatry Association, 2000); a pervasive pattern of instability in affect regulation, impulse control, interpersonal relationships, and self-image are linked to the clinical signs of emotional dysregulation, impulsive aggression, repeated self-injury, and chronic suicidal tendencies (Lieb et al., 2004). Some patients are able to sustain a certain level of social and occupational functioning, while others experience a very high level of emotional distress (cf. Jordanova and Rossin, 2010). There is often rapid fluctuation from periods of confidence to despair. Early-life stress exerts damaging effects on brain development (Archer, 2010a, b; Archer et al., 2010b) and neuroimaging studies (e.g. Koenigsberg et al., 2009) have yielded important insight into the role of the hypothalamic-pituitary-adrenal (HPA) axis in BPD (see Wingenfeld et al., 2010 for review).

Patients with BPD have shown volumetric reductions of the hippocampal and (in some cases) amygdala regions in structural MRI studies (Brambilla et al., 2004; Driessen et al., 2000; Schmahl et al., 2003), with or without comorbid aggression or depression (Zetsche et al., 2006, 2007). Krull et al. (2010) reviewed the multi-dimensional aspect of BPD from phenotypic, genetic, and endophenotypic perspectives. One major feature is the comorbid expression of the disorder with posttraumatic stress disorder which occurs in 50%-70% of patient populations (Zanarini et al., 1998b; Zimmermann and Mattia, 1999) with marked hippocampal volume reductions (Bremner et al., 1997, 2003; Stein et al., 1997; Zlotnick et al., 2003). Both BPD and PTSD share etiologic factors, e. g., trauma, symptom profiles (such as hyperarousal or dissociation states), and neurobiological factors (such as aberrant patterns of neural activation in prefrontal cortex and limbic regions; Schmahl and Bremner, 2006). Amygdala-deactivation has been indicated in BPD patients comorbid for PTSD but not those without PTSD (Kraus et al., 2009). Schmahl et al. (2009) compared a group of BPD with PTSD (n = 10) and a group of BPD without PTSD (n = 15) with 25 healthy female controls applying T1- and T2-weighted MRIs for manual tracing and 3-dimensional reconstruction of the hippocampus and amygdala. They found that the hippocampal volumes of BPD patients with PTSD were lower than those of the healthy female controls concomitant with significant correlations between impulsiveness and hippocampal volumes in these patients. These results and similar observations underlie the necessity of comorbidity considerations in BPD (Bahorik and Eack, 2010; Joshi et al., 2012; Rüsck et al., 2010).

BPD and antisocial personality disorders (ASPD) present common characteristics such as high levels of impulsiveness (Becker et al., 2005; Paris, 1997) and marked comorbidity (Chabrol and Leichsenring, 2006; Zanarini et al., 1998). Nevertheless, Völlm et al. (2004) have provided fMRI evidence that ASPD and BPD patients recruit different brain regions when successfully inhibiting pre-potent responses. Employing a Go/No Go task, they found that for healthy controls the main focus of activation during response inhibition was in the prefrontal cortex, in particular the right dorsolateral and the left orbitofrontal cortex. For ASPD and BPD patients, the active regions expressed a more bilateral and extended pattern of activation across the medial, superior and inferior frontal gyri extending to the anterior cingulate cortex. Völlm et al. (2009) studied the effects of positive (financial reward) and negative (financial loss) outcomes on blood-oxygen-level dependence (BOLD) responses in Cluster B (ASPD and BPD) patients ( $n = 8$ ) and healthy controls ( $n = 14$ ). They observed that: (i) there was an absence of prefrontal responses and reduced BOLD signal in the subcortical reward system of the patient group but not the control group, and (ii) for the patient group, but not control group, impulsiveness scores were correlated negatively with prefrontal responses during both reward and loss. The authors concluded that the response system to reward/loss in Cluster B was dysfunctional.

One prevailing notion is that emotional instability in BPD stems from an interaction of emotional vulnerability and an invalidating environment mediated hypersensitivity and hyperreactivity to emotional stimuli together with delayed return to baseline arousal level (Linehan, 1993; Linehan et al., 1999; Reeves et al., 2010). Niedtfeld et al. (2010) have found that both negative and neutral picture-presentations can lead to stronger activation of the amygdala, insula, and anterior cingulate cortex in patients with BPD compared with healthy controls. Structurally, a significant 24% reduction of the left orbitofrontal and a 26% reduction of the right anterior cingulate cortex in BPD in comparison to controls has been observed (Tebartz van Elst et al., 2003). Other studies show volumetric reductions of the hippocampus, orbitofrontal cortex and amygdala in BPD (Domes et al., 2009; Lis et al., 2007) and „ enhanced emotional-cue related activation in the amygdala (Donegan et al., 2003; Minzenberg et al., 2007), and middle and inferior temporal regions (Guitart-Masip et al., 2009) known to be involved in the processing of facial features carrying emotional content. Dyck et al. (2009) suggest that a selective deficit of BPD patients in rapid and direct discrimination of negative and neutral emotional expressions may in large part underlie their difficulties in social interactions.

In BPD, fronto-limbic neural dysfunction has been implicated in the expressions of emotional dysregulation and impulsivity. Using structural MRI and impulsiveness instrument, Takahashi et al (2009), examined the insular cortex volume and its relationship to clinical characteristics in a first-presentation teenage BPD sample of 20 BPD (5 male participants) and 20 healthy controls (5 male participants). They found no association between the insular volume and parasuicidal episodes, trauma exposure, or comorbid Axis I disorders; nevertheless, the BPD participants with a history of violent episodes during the previous 6 months showed a smaller insular volume bilaterally compared with those without such episodes. In addition, the right anterior insular volume in the BPD participants correlated negatively with the impulsiveness score. The potential relationship between the insular cortex volume and impulsiveness expression seems specific to BPD. Whittle et al. (2009) investigated anterior cingulate cortex volume in a first-presentation teenage BPD population with minimal exposure to treatment. Fifteen female BPD patients and 15 healthy female control participants underwent MRI scanning. Anterior cingulate cortex volumes

were estimated with a method that accounts for inter-individual variation in sulcal morphology with measurements between the two groups compared. ANOVA revealed a decrease in volume of the left anterior cingulate cortex in BPD patients compared with control participants that correlated with parasuicidal behavior and impulsivity. Anterior cingulate cortex volumetric asymmetry correlated also with fear of abandonment symptoms, implying that these volumetric abnormalities early in the course of BPD may relate to the clinical correlates of the disorder. Krause et al. (2010) explored the neural correlates of script-driven imagery of self-injurious behavior in female BPD patients and healthy controls. When imagining the reactions to a situation triggering self-injurious behavior, BPD patients showed significantly less activation in the orbitofrontal cortex but increased activity in the DLPFC. Imagining the self-injurious act itself was associated with a decrease in the mid-cingulate in the patient group. Together, these structural and functional neuroimaging findings suggest that frontal, insular, mid- and anterior cingulate regions and medial temporal lobe structures may be critically involved in the impaired regulation of impulse and affect observed in BPD (e.g., Soloff et al., 2008).

In conclusion, the notions of aberrant reward learning, dysregulated response inhibition and pathological hypersensitivity to temporal delays in reinforcement form the essential behavioural endophenotype of impulsiveness that is witnessed in ADHD and BPD, as well as in compulsive gambling, addictive disorders and dopamine dysregulation syndrome. Developmental trajectories of impulsive behaviors and the damaging effects of early-life trauma on brain development bear essential outcome-expectancies for eventual understanding of etiopathogenesis. Structural and functional resonance imaging has served to provide a point of convergence for the resolution of neurobehavioural, epigenetic and neurodevelopmental factors.

## 2. References

- Ahrendts J, Rüsç N, Wilke M, Philipsen A, Eickhoff SB, Glauche V, Perlov E, Ebert D, Hennig J, Tebartz van Elst L (2010) Visual cortex abnormalities in adults with ADHD: A structural MRI study. *World J Biol Psychiatry* 12, 260-270.
- Ainslie, G. (1975). Specious reward: a behavioral theory of impulsiveness and impulse control. *Psychol Bull* 82, 463-496.
- American Psychiatry Association (2000) Diagnostic and Statistical Manual of Mental Disorders. 4<sup>th</sup> Edition, Washington, DC: American Psychiatric Press.
- Amico F, Stauber J, Koutsouleris N, Frodl T (2011) Anterior cingulate cortex gray matter abnormalities in adults with attention deficit hyperactivity disorder: A voxel-based morphometry study. *Psychiatry Res: Neuroimaging* 191, 31-35.
- Archer T (2010a) Neurodegeneration in schizophrenia. *Expert Rev Neurother* 10, 1131-1141.
- Archer T (2010b) Effects of exogenous agents on brain development: Stress, abuse and therapeutic compounds. *CNS Neurosci Ther* 17, 470-489.
- Archer T, Kostrzewa RM, Beninger RJ, Palomo T (2010b) Staging perspectives in neurodevelopmental aspects of neuropsychiatry: agents, phases and ages at expression. *Neurotox Res* 18, 287-305.
- Archer T, Beninger RJ, Palomo T and Kostrzewa RM (2010a) Epigenetics and biomarkers in the etiopathogenesis of neuropsychiatric disorders. *Neurotoxicity Res* 18 347-366.
- Aron AR, Robbins TW, Poldrack RA (2004) Inhibition and the right inferior frontal cortex. *Tr Cogn Sci* 8 170-177.

- Asahi S, Okamoto Y, Okada G, Yamawaki S, Yokota N (2004) Negative correlation between right prefrontal activity during response inhibition and impulsiveness: a fMRI study. *Eur Arch Psychiatr Clin Sci* 254, 245-251.
- Bahorik AL, Eack SM (2010) Examining the course and outcome of individuals diagnosed with schizophrenia and comorbid borderline personality disorder. *Schizophr Res* 124, 29-35.
- Ballard K, Knutson B (2009) Dissociable neural representations of future reward magnitude and delay during temporal discounting. *Neuroimage* 45 143-150.
- Barratt ES, Patton JH (1983) Impulsivity: cognitive, behavioural, and psychophysiological correlates. In: *Biological Basis of Sensation-seeking, Impulsivity and Anxiety* (Zuckerman M, Ed), LEA: Hillsdale, NJ, pp. 77-116.
- Barratt ES, Stanford MS, Kent TA, Felthous A (1997) Neuropsychological and psychophysiological substrates of impulsive aggression. *Biol Psychiatr* 41, 1045-1061.
- Barkley RA (1997) Behavioural inhibition, sustained attention, and executive functions: constructing a unified theory of ADHD. *Psychol Bull* 121, 65-94.
- Barkley RA, Fischer M (2010) The unique contribution of emotional impulsiveness to impairment in major life activities in hyperactive children as adults. *J Am Acad Child Adolesc Psychiatr* 49, 503-513.
- Barkley RA, Koplowitz S, Anderson T, McMurray MB (1997) Sense of time in children with ADHD: effects of duration, distraction and stimulant medication. *J Int Neuropsychol Soc* 3, 359-369.
- Barkley RA, Murphy KR, Bush T (2001) Time perception and reproduction in young adults with attention deficit hyperactivity disorder. *Neuropsychology* 15, 351-360.
- Barratt ES (1994) Impulsiveness and aggression. In: *Violence and Mental Disorder* (Monahan J, Steadman HJ, eds) Chicago, IL: University of Chicago Press, pp. 61-79.
- Barros-Loscertales A, Meseguer V, Sanjuan A, Belloch V, Parcet MA, Torrubia R, Avila C (2006) Striatum grey matter reduction in males with an overactive behavioural activation system. *Eur J Neurosci* 24, 1943-1961.
- Batterink L, Yokum S, Stice E (2010) Body mass correlates inversely with inhibitory control in response to food among adolescent girls: an fMRI study. *Neuroimage* 52, 1696-1703.
- Beaver JD, Lawrence AD, van Ditzhuizen J, Davis MH, Woods A, Calder AJ (2006) Individual differences in reward drive predict neural response to images of food. *J Neurosci* 26, 5160-5166.
- Beck A, Schlagenhauf F, Wüstenberg T, Hein J, Kienast T, Kahnt T, Schmack K, Hägele C, Knutson B, Heinz A, Wrase J (2009) Ventral striatal activation during reward anticipation correlates with impulsivity in alcoholics. *Biol Psychiatr* 66, 734-742.
- Becker DF, Grilo CM, Anez LM, Paris M, McGlashan TH (2005) Discriminant efficiency of antisocial and borderline personality disorder criteria in Hispanic men with substance abuse disorders. *Comprehen Psychiatr* 46, 140-146.
- Bickel WK, Odum AL, Madden GJ (1999) Impulsivity and cigarette smoking: delay discounting in current, never, and ex-smokers. *Psychopharmacology (Berl)* 146, 447-454.
- Blakemore SJ (2008) The social brain in adolescence. *Nat Rev Neurosci* 9, 267-277.
- Blumberg HP, Martin A, Kaufman J, Leung HC, Skudlarski P, Lacadie C, Fulbright RK, Gore JC, Charney DS, Krystal JH, Peterson BS (2003) Frontostriatal abnormalities in adolescents with bipolar disorder: preliminary observations from functional MRI. *Am J Psychiatr* 160, 1345-1347.



- Brambilla P, Soloff PH, Sala M, Nicoletti MA, Keshavan MS, Soares JC (2004) Anatomical MRI study of borderline personality disorder patients. *Psychiatry Res* 131, 125-133.
- Bremner JD, Randall P, Vermetten E, Staib L, Bronen RA, Mazure C, Capelli S, McCarthy G, Innis RB, Charney DS (1997) Magnetic resonance imaging-based measurement of hippocampal volume in posttraumatic stress disorder related to childhood physical and sexual abuse--a preliminary report. *Biol Psychiatry* 41, 23-32.
- Bremner JD, Vythilingam M, Vermetten E, Southwick SM, McGlashan T, Nazeer A, Khan S, Vaccarino LV, Soufer R, Garg PK, Ng CK, Staib LH, Duncan JS, Charney DS (2003) MRI and PET study of deficits in hippocampal structure and function in women with childhood sexual abuse and posttraumatic stress disorder. *Am J Psychiatry* 160, 924-932.
- Buss AH, Plomin R (1975) *A Temperament Theory of Personality Development*. New York, NY: Wiley.
- Calvert AL, Green L, Myerson J (2010) Delay discounting of qualitatively different reinforcers in rats. *J Exp Anal Behav* 93, 171-184.
- Carmona S, Proal E, Hoekzema EA, Gispert J-D, Picado M, Moreno I, Soliva JC, Bielsa A, Rovira M, Hilferty J, Bulbena A, Casas M, Tobena A, Vilarroya O (2009) Ventrostriatal reductions underpin symptoms of hyperactivity and impulsivity in attention-deficit/hyperactivity disorder. *Biol Psychiatr* 66, 972-977.
- Casey BJ, Castellanos FX, Giedd JN, Marsh WL, Hamburger SD, Schubert AB, Vauss YC, Vaituzis AC, Dickstein DP, Sarfatti SE, Rapaport JL (1997) Implication of right frontostriatal circuitry in response inhibition and attention-deficit/hyperactivity disorder. *J Am Acad Child Adolesc Psychiatr* 36, 374-383.
- Castellanos FX, Sharp WS, Gottesman RF, Greenstein DK, Giedd JN, Rapoport JL (2003) Anatomic brain abnormalities in monozygotic twins discordant for attention deficit hyperactivity disorder. *Am J Psychiatr* 160, 1693-1696.
- Celikel FC, Kose S, Cumurcu BE, Erkorkmaz U, Sayar K, Borckardt JJ, Cloninger CR (2009) Cloninger's temperament and character dimensions of personality in patients with major depressive disorder. *Compr Psychiatry* 50, 556-561.
- Chabrol H, Leichsenring F (2006) Borderline personality organization and psychopathic traits in nonclinical adolescents: relationships of identity diffusion, primitive defense mechanisms and reality testing with callousness and impulsivity traits. *Bull Menninger Clin* 70, 160-170.
- Chamberlain SR, Sahakian BJ (2007) The neuropsychiatry of impulsivity. *Curr Opin Psychiatr* 20, 255-261.
- Chamberlain SR, Robbins TW, Winder-Rhodes S, Müller U, Sahakian BJ, Blackwell AD, Barnett JH (2010) Translational approaches to frontostriatal dysfunction in attention-deficit/hyperactivity disorder using a computerized neuropsychological battery. *Biol Psychiatry* 69, 1192-203.
- Christakou A, Brammer M, Rubia K (2010) Maturation of limbic corticostriatal activation and connectivity associated with developmental changes in temporal discounting. *Neuroimage* 54, 1344-1354.
- Cloninger CR, Zohar AH (2011) Personality and the perception of health and happiness. *J Affect Disord* 128, 24-32.
- Congdon E, Canli T (2005) The endophenotype of impulsivity: reaching consilience through behavioural, genetic, and neuroimaging approaches. *Behav Cogn Neurosci Rev* 4, 262-281.

- Coull J, Nobre A (2008) Dissociating explicit timing from temporal expectation with fMRI. *Curr Opin Neurobiol* 18, 137-144.
- Crews FT, Boettiger CA (2009) Impulsivity, frontal lobes and risk for addiction. *Pharmacol Biochem Behav* 93, 237-247.
- Cyders MA, Flory K, Rainer S, Smith G (2009) The role of personality dispositions to risky behaviour in predicting first-year college drinking. *Addiction* 104, 193-202.
- Cyders MA, Smith GT (2008a) Emotion-based dispositions to rash action: positive and negative urgency. *Psychol Bull* 134, 807-828.
- Cyders MA, Smith GT (2008b) Clarifying the role of personality dispositions in risk for increased gambling behaviour. *Pers Individ Diff* 45, 503-508.
- Cyders MA, Smith GT (2009) Longitudinal validation of the urgency traits over the first year of college. *J Pers Assess* 92, 63-9.
- Cyders MA, Zapolski TC, Combs JL, Settles RF, Fillmore MT, Smith GT (2010) Experimental effect of positive urgency on negative outcomes from risk taking and on increased alcohol consumption. *Psychol Addict Behav* 24, 367-375.
- Dalen L, Sonuga-Barke EJ, Hall M, Remington B (2004) Inhibitory deficits, delay aversion and preschool AD/HD: implications for the dual pathway model. *Neural Plast* 11, 1-11.
- de Jong LW, Wang Y, White LR, Yu B, Buchem MA, Launer LJ (2012) Ventral striatal volume is associated with cognitive decline in older people: A population based MR-study. *Neurobiol Aging* 33, 424.e1-10.
- de Wit H (2009) Impulsivity as a determinant and consequence of drug use: a review of underlying processes. *Addict Biol* 14, 22-31.
- Depue BE, Burgess GC, Bidwell LC, Willcutt EG, Banich MT (2010a) Behavioural performance predicts grey matter reductions in the right inferior frontal gyrus in young adults with combined type ADHD. *Psychiatry Res* 182, 231-237.
- Depue BE, Burgess GC, Willcutt EG, Bidwell LC, Ruzic L, Banich MT (2010) Symptom-correlated brain regions in young adults with combined-type ADHD: their organization, variability, and relation to behavioural performance. *Psychiatry Res* 182, 96-102.
- Dillo W, Göke A, Prox-Vagedes V, Szycik GR, Roy M, Donnerstag F, Emrich HM, Ohlmeier MD (2010) Neuronal correlates of ADHD in adults with evidence for compensation strategies--a functional MRI study with a Go/No-Go paradigm. *Ger Med Sci* 8, Doc09.
- Dolan MC, Deakin JFW, Roberts N, Anderson IM (2002) Serotonergic and cognitive impairment in impulsive aggressive personality disorders offenders: are there implications for treatment? *Psychol Med* 32, 105-117.
- Dolan M, Park I (2002) The neuropsychology of antisocial personality disorder. *Psychol Med* 32, 417-27.
- Domes G, Schulze L, Herpertz SC (2009) Emotion recognition in borderline personality disorder - a review of the literature. *J Personal Disord* 23, 6-19.
- Donegan NH, Sanislow CA, Blumberg HP, Fulbright RK, Lacadie C, Scudlarski P et al (2003) Amygdala hyperreactivity in borderline personality disorder: implications for emotional dysregulation. *Biol Psychiatry* 54, 1284-1293.
- Driessen M, Herrmann J, Zwaan M, Meier S, Hill A, Osterheider M, Petersen D (2000) Magnetic resonance imaging volumes of the hippocampus and amygdala in

- women with borderline personality disorder and early traumatization. *Arch Gen Psychiatr* 57, 1115-1122.
- Durston S, Davidson MC, Mulder MJ, Spicer JA, Galvan A, Tottenham N, Scheres A, Xavier Castellanos F, van Engeland H, Casey BJ (2007) Neural and behavioural correlates of expectancy violations in attention-deficit hyperactivity disorder. *J Child Psychol Psychiatry* 48, 881-9.
- Durston S, Mulder M, Casey BJ, Ziermans T, van Engeland H (2006) Activation in ventral prefrontal cortex is sensitive to genetic vulnerability for attention deficit hyperactivity disorder. *Biol Psychiatr* 60, 1062-1070.
- Durston S, Tottenham NT, Thomas KM, Davidson MC, Eigsti IM, Yang Y, Ulug AM, Casey BJ (2003) Differential patterns of striatal activation in young children with and without ADHD. *Biol Psychiatr* 53, 871-878.
- Dyck M, Habel U, Slodczyk J, Schlummer J, Backes V, Schneider F, Reske M (2009) Negative bias in fast emotion discrimination in borderline personality disorder. *Psychol Med* 39, 855-864.
- Elliott R, Deakin B (2005) Role of the orbitofrontal cortex in reinforcement processing and inhibitory control: evidence from functional magnetic resonance imaging studies in healthy human subjects. *Int Rev Neurobiol* 65, 89-116.
- Elliott R, Newman JL, Longe OA, Deakin JF (2003) Differential response patterns in the striatum and orbitofrontal cortex to financial reward in humans: a parametric functional magnetic resonance imaging study. *J Neurosci* 23, 303-307.
- Estle SJ, Green L, Myerson J, Holt DD (2006) Differential effects of amount on temporal and probability discounting of gains and losses. *Mem Cognit* 34, 914-28.
- Evenden J, Ko T (2005) The psychopharmacology of impulsive behaviour in rats VIII: effects of amphetamine, methylphenidate, and other drugs on responding maintained by a fixed consecutive number avoidance schedule. *Psychopharmacology* 180, 294-305.
- Eysenck SGB (1993) The nature of Impulsivity. In: *The Impulsive Client: Theory, Research and Treatment* (McCown WG, Johnson AL, Shure MB, eds) Washington, DC: American Psychological Association.
- Fayyad J, De Graaf R, Alonso J, Angermeyer M, Demyttenaere K, De Girolamo G, Haro JM, Karam EG, Lara C, Lépine JP, Ormel J, Posada-Villa J, Zaslavsky AM (2007). Cross-national prevalence and correlates of adult attention-deficit hyperactivity disorder. *Brit J Psychi* 190, 402-409.
- Filipek PA, Semrud-Clikeman M, Steingard RJ, Renshaw PF, Kennedy DN, Biederman J (1997) Volumetric MRI analysis comparing subjects having attention-deficit hyperactivity disorder with normal controls. *Neurology* 48, 589-601.
- Frank MJ, Claus ED (2006) Anatomy of a decision: striato-orbitofrontal interactions in reinforcement learning, decision making and reward. *Psychol Rev* 113, 300-326.
- Franken IH, Muris P, Georgieva I (2006) Gray's model of personality and addiction. *Addict Behav* 31, 399-403.
- Galenter CA and Leibenluft E (2008) Frontiers between attention deficit hyperactivity disorder and bipolar disorder. *Child Adolesc Psychiatr Clin N Am* 17, 325- 346.
- Giedd JN, Rapoport JL (2010) Structural MRI of pediatric brain development: what have we learned and where are we going? *Neuron* 67, 728-734.
- Gilden DL, Marusich LR (2009) Contraction of time in attention-deficit hyperactivity disorder. *Neuropsychology* 23, 265-269.

- Goya-Maldonado R, Walther S, Simon J, Stippich C, Weisbrod M, Kaiser S (2010) Motor impulsivity and the ventrolateral prefrontal cortex. *Psychiatr Res Neuroimaging* 183, 89-91.
- Grall-Bronnec M, Bouju G, Landréat-Guillou M, Vénisse JL (2010) [Socio-demographic and clinical assessment, and trajectory of a sample of French pathological gamblers.] *Encephale* 36, 452-460.
- Gray JA (1982) *The Neuropsychology of Anxiety: An Enquiry into the Functions of the Septo-hippocampal system*. Oxford University Press, Oxford.
- Gray JA (1991) The neuropsychology of temperament. In: Strelau J, Angleitner A (eds.), *Explorations in Temperament*. Plenum Press, New York, pp. 105-128.
- Gray JA, McNaughton N (2000) *The Neuropsychology of Anxiety: An Enquiry into the Functions of the Septo-hippocampal system*. 2<sup>nd</sup> Edition, Oxford University Press, Oxford.
- Green L, Myerson J (2004) A discounting framework for choice with delayed and probabilistic rewards. *Psychol Bull* 130, 769-792.
- Guitart-Masip M, Pascual JC, Carmona S, Hoekzema E, Bergé D, Pérez V, Soler J, Soliva JC, Rovira M, Bulbena A, Vilarroya O (2009) Neural correlates of impaired emotional discrimination in borderline personality disorder: an fMRI study. *Prog Neuropsychopharmacol Biol Psychiatry* 33, 1537-1345.
- Ha RY, Namkoong K, Kang JI, Kim YT, Kim SJ (2010) Interaction between serotonin transporter promoter and dopamine receptor D4 polymorphisms on decision making. *Prog Neuropsychopharmacol Biol Psychiatry* 33, 1217-1222.
- Haase CM, Silbereisen RK (2010) Effects of positive affect on risk perceptions in adolescence and young adulthood. *J Adolesc* 34, 29-37.
- Haden SC, Shiva A (2008) Trait impulsivity in a forensic inpatient sample: an evaluation of the Barratt impulsiveness scale. *Behav Sci Law* 26, 675-690.
- Hahn T, Dresler T, Ehlis A-C, Plichta MM, Heinz S, Polak T, Lesch K-P, Breuer F, Jakob PM, Fallgatter AJ (2009) Neural response to reward anticipation is modulated by Gray's impulsivity. *Neuroimage* 46, 1148-1153.
- Hahn T, Heinz S, Dresler T, Plichta MM, Renner TJ, Markulin F, Jakob PM, Lesch KP, Fallgatter AJ (2010) Association between reward-related activation in the ventral striatum and trait reward sensitivity is moderated by dopamine transporter genotype. *Hum Brain Mapp* 32, 1557-65.
- Halperin JM, Schulz KP (2006) Revisiting the role of prefrontal cortex in the pathophysiology of attention-deficit/hyperactivity disorder. *Psychol Bull* 132, 560-581.
- Harrison EL, Coppola S, McKee SA (2009) Nicotine deprivation and trait impulsivity affect smokers' performance on cognitive tasks of inhibition and attention. *Exp Clin Psychopharmacol* 17, 91-98.
- Helmers KF, Young SN, Pihl RO (1995) Assessment of measures of impulsivity in healthy male volunteers. *Pers Individ Diff* 19, 927-935.
- Hooley JM, Gruber SA, Parker HA, Guillaumot J, Rogowska J, Yurgelun-Todd DA (2010) Neural processing of emotional overinvolvement in borderline personality disorder. *J Clin Psychiatry* 71, 1017-1024.
- Horn NR, Dolan M, Elliott R, Deakin JF, Woodruff PW (2003) Response inhibition and impulsivity: an fMRI study. *Neuropsychologia* 41, 1959-1966.
- Ivry RB, Spencer RM (2004) The neural representation of time. *Curr Opin Neurobiol* 14, 225-232.



- Jordanova V, Rossin P. (2010). Borderline personality disorder often goes undetected. *Practitioner* 254(1729), 23-6.
- Joshi G, Biederman J, Wozniak J, Doyle R, Hammerness P, Galdo M, Sullivan N, Williams C, Brethel K, Woodworth KY, Mick E (2012) Response to Second Generation Antipsychotics in Youth with Comorbid Bipolar Disorder and Autism Spectrum Disorder. *CNS Neurosci Ther* 18, 28-33.
- Kalia M (2008) Brain development: anatomy, connectivity, adaptive plasticity, and toxicity. *Metabolism* 57 [Suppl 2], S2-S5.
- Keilp JG, Sackeim HA, Mann JJ (2005) Correlates of trait impulsiveness in performance measures and neuropsychological tests. *Psychiatr Res* 135, 191-201.
- Kemps E, Wilsdon A (2010) Preliminary evidence for a role for impulsivity in cognitive disinhibition in bulimia nervosa. *J Clin Exp Neuropsychol* 32, 515-521.
- Kobel M, Bechtel N, Specht K, Klarhöfer M, Weber P, Scheffler K, Opwis K, Penner IK (2010) Structural and functional imaging approaches in attention deficit/hyperactivity disorder: does the temporal lobe play a key role? *Psychiatry Res* 183, 230-236.
- Koenigs M, Tranel D (2007) Irrational economic decision-making after ventromedial prefrontal damage: evidence from the Ultimate game. *J Neurosci* 27, 951-956.
- Koenigsberg HW, Fan J, Ochsner KN, Liu X, Guise KG, Pizzarello S, Dorantes C, Guerreri S, Tecuta L, Goodman M, New A, Siever LJ (2009) Neural correlates of the use of psychological distancing to regulate responses to negative social cues: a study of patients with borderline personality disorder. *Biol Psychiatry* 66, 854-863.
- Konrad A, Dielentheis TF, El Masri D, Bayerl M, Fehr C, Gesierich T, Vucurevic G, Stoeter P, Winterer G (2010) Disturbed structural connectivity is related to inattention and impulsivity in adult attention deficit hyperactivity disorder. *Eur J Neurosci* 31, 912-919.
- Kraus A, Esposito F, Seifritz E, Di Salle F, Ruf M, Valerius G, Ludaescher P, Bohus M, Schmahl C (2009) Amygdala deactivation as a neural correlate of pain processing in patients with borderline personality disorder and co-occurrent posttraumatic stress disorder. *Biol Psychiatry* 65, 819-822.
- Kraus A, Valerius G, Seifritz E, Ruf M, Bremner JD, Bohus M, Schmahl C (2010) Script-driven imagery of self-injurious behavior in patients with borderline personality disorder: a pilot fMRI study. *Acta Psychiatrica Scandinavica* 121, 41-51
- Krishnan-Sarin S, Reynolds B, Duhig AM, Smith A, Liss T, McFetridge A, Cavallo DA, Carroll KM, Potenza MN (2007) Behavioural impulsivity predicts treatment outcome in a smoking cessation program for adolescent smokers. *Drug Alcohol Depend* 88, 79-82.
- Kurian JR, Bychowski ME, Forbes-Lorman RM, Auger CJ and Auger AP (2008) Mecp2 organizes juvenile social behaviour in a sex-specific manner. *J Neurosci* 28, 7137-7142.
- Kwok SL, Shek DT (2010) Cognitive, emotive, and cognitive-behavioural correlates of suicidal ideation among Chinese adolescents in Hong Kong. *ScientificWorld Journal* 5, 366-379.
- Lach LM, Kohen DE, Garner RE, Brehaut JC, Miller AR, Klassen AF and Rosenbaum PL (2009) The health and psychosocial functioning of caregivers of children with neurodevelopmental disorders. *Disabil Rehabil* 31, 741-752.
- Lambek R, Tannock R, Dalsgaard S, Trillingsgaard A, Damm D, Thomsen PH (2011) Executive Dysfunction in School-Age Children With ADHD. *J Atten Disord* 15, 646-655.

- Lee TMY, Guo L, Shi H, Li Y, Luo Y, Sung CYY, Chan CCH, Lee TMC (2009) Neural correlates of Traditional Chinese Medicine induced advantageous risk-taking decision-making. *Brain Cogn* 71, 354-361.
- Leibenluft E, Rich BA, Vinton DE, Nelson EE, Fromm SJ, Berghorst LH, Joshi P, Robb A, Schachar RJ, Dickstein DP, McClure EB, Pine DS (2007) Neural circuitry engaged during unsuccessful motor inhibition in pediatric bipolar disorder. *Am J Psychiatr* 164, 52-60.
- Lejuez CW, Bornoalova MA, Reynolds EK, Daughters SB, Curtin JJ (2007) Risk factors in the relationship between gender and crack/cocaine. *Exp Clin Psychopharmacol* 15, 165-175.
- Lieb K, Zanarini MC, Schmahl C, Linehan MM, Bohus M (2004) Borderline personality disorder. *Lancet* 364, 453-461.
- Linehan MM, Schmidt H 3rd, Dimeff LA, Craft JC, Kanter J, Comtois KA (1999) Dialectical behaviour therapy for patients with borderline personality disorder and drug-dependence. *Am J Addict* 8, 279-292.
- Logue AW (1975) *Self-control*. Englewood Cliffs, NJ: Prentice-Hall.
- Love TM, Stohler CS, Zubieta JK (2009) Positron emission tomography measures of endogenous opioid neurotransmissions and impulsiveness traits in humans. *Arch Gen Psychiatr* 66, 1124-1134.
- Luman M, Tripp G, Scheres A (2010) Identifying the neurobiology of altered reinforcement sensitivity in ADHD: a review and research agenda. *Neurosci Biobehav Rev* 34, 744-754.
- Luna B, Sweeney JA (2004) The emergence of collaborative brain function: fMRI studies of the development of response inhibition. *Ann NY Acad Sci* 1021, 296-309.
- Ma Alvarez-Moya E, Jiménez-Murcia S, Aymamí MN, Gómez-Peña M, Granero R, Santamaría J, Menchón JM, Fernández-Aranda F (2010) Subtyping study of a pathological gamblers sample. *Can J Psychiatry* 55, 498-506.
- Makris N, Biederman J, Valera EM, Bush G, Kaiser J, Kennedy DN, Caviness VS, Faraone SV, Seidman LJ (2007) Cortical thinning of the attention and executive function networks in adults with attention-deficit/hyperactivity disorder. *Cereb Cortex* 17, 1364-1375.
- Martinotti G, Mandelli L, Di Nicola M, Serretti A, Fossati A, Borroni S, Cloninger CR, Janiri L (2008) Psychometric characteristic of the Italian version of the Temperament and Character Inventory--revised, personality, psychopathology, and attachment styles. *Compr Psychiatry* 49, 514-522.
- Mattison RE, Mayes SD (2012) Relationships between learning disability, executive function, and psychopathology in children with ADHD. *J Atten Disord* 16, 138-146.
- Marx I, Hübner T, Herpertz SC, Berger C, Reuter E, Kircher T, Herpertz-Dahlmann B, Konrad K (2010) Cross-sectional evaluation of cognitive functioning in children, adolescents and young adults with ADHD. *J Neural Transm* 117, 403-419.
- McInerney RJ, Kerns KA (2003) Time reproduction in children with ADHD: motivation matters. *Child Neuropsychol* 9, 91-108.
- Meaux JB, Chelonis JJ (2003) Time perception differences in children with and without ADHD. *J Pediatr Health Care* 17, 64-71.
- Meck WH, Benson AM (2002) Dissecting the brain's internal clock: How frontal-striatal circuitry keeps time and shifts attention. *Brain Cogn* 48, 195-211.

- Miller DJ, Vachon DD, Lynam DR (2009) Neuroticism, Negative Affect, and Negative Affect Instability: Establishing Convergent and Discriminant Validity Using Ecological Momentary Assessment. *Pers Individ Diff* 47, 873-877.
- Mitchell JT, Nelson-Gray RO (2006) Attention-deficit/hyperactivity disorder symptoms in adults: relationship to Gray's behavioural approach system. *Pers Individ Differ* 40, 749-760.
- Moeller FG, Barratt ES, Dougherty DM, Schmitz JM, Swann AC (2001) Psychiatric aspects of impulsivity. *Am J Psychiatry* 158, 1783-1793.
- Mostofsky SH, Cooper KL, Kates WR, Denckla MB, Kaufmann WE (2002) Smaller prefrontal and premotor volumes in boys with ADHD. *Biol Psychiatry* 52, 785-794.
- Niedtfeld I, Schulze L, Kirsch P, Herpertz SC, Bohus M, Schmahl C (2010) Affect regulation and pain in borderline personality disorder: a possible link to the understanding of self-injury. *Biol Psychiatry* 68, 383-391.
- Overmeyer S, Bullmore ET, Suckling J, Simmons A, Williams SC, Santosh PJ, Taylor E (2001) Distributed grey and white matter deficits in hyperkinetic disorder: MRI evidence for anatomical abnormality in an attentional network. *Psychol Med* 31, 1425-1435.
- Palijan TZ, Radeljak S, Kovac M, Kovacević D (2010) Relationship between comorbidity and violence risk assessment in forensic psychiatry - the implication of neuroimaging studies. *Psychiatr Danub* 22, 253-256.
- Palomo T, Beninger RJ, Kostrzewa RM, Archer T (2007a) Treatment consideration and manifest complexity in comorbid neuropsychiatric disorders. *Neurotoxicity Res* 12, 43-60.
- Palomo T, Beninger RJ, Kostrzewa RM, Archer T (2007b) Comorbidity implications in brain disease: neuronal substrates of symptom profiles. *Neurotox Res* 12, 1-15.
- Palomo T, Beninger RJ, Kostrzewa RM, Archer T (2008a) Focusing on symptoms rather than diagnoses in brain dysfunction: conscious and nonconscious expression in impulsiveness and decision-making. *Neurotoxicity Res* 14, 1-20.
- Palomo T, Beninger RJ, Kostrzewa RM, Archer T (2008b) Affective status in relation to impulsive, motor and motivational symptoms: personality, development and physical exercise. *Neurotoxicity Res* 14, 151-168.
- Paris J (1997) Antisocial and borderline personality disorders: two separate diagnoses or two aspects of the same psychopathology? *Comprehen Psychiatr* 38, 237-242.
- Park HS, Kim SH, Bang SA, Yoon EJ, Cho SS, Kim SE (2010) Altered regional cerebral glucose metabolism in internet game overusers: a 18F-fluorodeoxyglucose positron emission tomography study. *CNS Spectr* 15, 159-166.
- Park SQ, Kahnt T, Beck A, Cohen MX, Dolan RJ, Wrase J, Heinz A (2010) Prefrontal cortex fails to learn from reward prediction errors in alcohol dependence. *J Neurosci* 30, 7749-7753.
- Passamonti I, Fera F, Magariello A, Cerasa A, Gioia MC, Muglia M, Nicoletti G, Gallo O, Provinciali L, Quattrone A (2006) Monoamine oxidase-A genetic variations influence brain activity associated with inhibitory control: new insight into the neural correlates of impulsivity. *Biol Psychiatry* 59, 334-340.
- Passarotti AM, Sweeney JA, Pavuluri MN (2010) Neural correlates of response inhibition in pediatric bipolar disorder and attention deficit hyperactivity disorder. *Psychiatr Res Neuroimaging* 181, 36-43.
- Paus T, Keshavan M, Giedd JN (2008) Why do many psychiatric disorders emerge during adolescence? *Nat Rev Neurosci* 9, 947-957.

- Pavuluri MN, Passarotti AM (2008) Neural bases of emotional processing in pediatric bipolar disorder. *Expert Rev Neurotherap* 8, 1381-1387.
- Pavuluri MN, Shenkel LS, Aryal S, Harral E, Hill K, Herbener ES, Sweeney JA (2006) Neurocognitive function in unmedicated manic and medicated euthymic pediatric bipolar patients. *Am J Psychiatr* 163, 286-293.
- Pavuluri MN, O'Connor MM, Harral EM, Sweeney JA (2007) Affective neural circuitry during facial emotion processing in pediatric bipolar disorder. *Biol Psychiatr* 62, 158-167.
- Pavuluri MN, O'Connor MM, Harral EM, Sweeney JA (2008) An fMRI study of the interface between affective and cognitive neural circuitry in pediatric bipolar disorder. *Psychiatr Res* 162, 244-245.
- Peluso MA, Hatch JP, Glahn DC, Monkul ES, Sanches M, Najt P, Bowden CL, Barratt ES, Soares JC (2007) Trait impulsivity in patients with mood disorders. *J Affect Disord* 100, 227-231.
- Petry NM (2002) Discounting of delayed rewards in substance abusers: relationship to antisocial personality disorder. *Psychopharmacology* 162, 425-432.
- Pfefferbaum B, Wood PB (1994) Self-report study of impulsive and delinquent behaviour in college students. *J Adolesc Health* 15, 295-302.
- Pierò A (2010) Personality correlates of impulsivity in subjects with generalized anxiety disorders. *Compr Psychiatry* 51, 538-545.
- Pine A, Shiner T, Seymour B, Dolan RJ (2010) Dopamine, time, and impulsivity in humans. *J Neurosci* 30, 8888-8896.
- Plichta MM, Vasic N, Wolf RC, Lesch KP, Brummer D, Jacob C, Fallgatter AJ, Grön G (2009) Neural hyporesponsiveness and hyperresponsiveness during immediate and delayed reward processing in adult attention-deficit/hyperactivity disorder. *Biol Psychiatr* 65, 7-14.
- Plitzka SR, Glahn DC, Semrud-Clikeman M, Franklin C, Perez R, Xiong J, Liotti M (2006) Neuroimaging of inhibitory control areas in children with attention deficit hyperactivity disorder who were treatment naïve or in long-term treatment. *Am J Psychiatr* 163, 1052-1060.
- Potter AS, Newhouse PA (2004) Effects of acute nicotine administration on behavioural inhibition in adolescents with attention-deficit/hyperactivity disorder. *Psychopharmacology* 176, 182-194.
- Powell J, Dawkins L, West R, Powell J, Pickering A (2010) Relapse to smoking during unaided cessation: clinical, cognitive and motivational predictors. *Psychopharmacology* 212, 537-549.
- Prévost C, Pessiglione M, Météreau E, Cléry-Melin ML, Dreher JC (2010) Separate valuation subsystems for delay and effort decision costs. *J Neurosci* 30, 14080-14090.
- Qiu A, Crocetti D, Adler M, Mahone EM, Denckla MB, Miller MI, Mostofsky SH (2009) Basal ganglia volume and shape in children with attention deficit hyperactivity disorder. *Am J Psychiatr* 166, 74-82.
- Quirk SW, McCormick RA (1998) Personality subtypes, coping styles, symptom correlates, and substances of choice among a cohort of substance abusers. *Assessment* 5, 157-169.
- Radonovich KJ, Mostofsky SH (2004) Duration judgements in children with ADHD suggest deficit utilization of temporal information rather than general impairment in timing. *Child Neuropsychol* 10, 162-172.



- Raine A, Dodge K, Loeber R, Gatzke-Kopp L, Lynam D, Reynolds C, Stouthamer-Loeber M, Liu J (2006) The Reactive-Proactive Aggression Questionnaire: Differential Correlates of Reactive and Proactive Aggression in Adolescent Boys. *Aggress Behav* 32, 159-171.
- Reynolds B (2006) A review of delay-discounting research with humans: relations to drug use and gambling. *Behav Pharmacol* 17, 651-667.
- Reynolds WM, Stark KD (1986) Self-control in children: a multimethod examination of treatment outcome measures. *J Abnorm Child Psychol* 14, 13-23.
- Rivalan M, Gregoire S, dellu-Hagedorn F (2007) Reduction of impulsivity with amphetamine in an appetitive fixed consecutive number schedule with cue for optimal performance in rats. *Psychopharmacology* 192, 171-182.
- Rogers RD (2003) Neuropsychological investigations of the impulsive personality disorders. *Psychol Med* 33, 1335-1340.
- Rogers RD, Owen AM, Middleton HC, Williams EJ, Pickard JD, Sahakian BJ, Robbins TW (1999) Choosing between small, likely rewards and large, unlikely rewards activates inferior and orbital prefrontal cortex. *J Neurosci* 19, 9029-9038.
- Rubia K (2002) The dynamic approach to developmental psychiatric disorders: use of fMRI combined with neuropsychology to elucidate the dynamics of psychiatric disorders, exemplified in ADHD and Schizophrenia. *Behav Brain Res* 130, 47-56.
- Rubia K, Smith AB, Oksannan H, Fumie MM, Taylor E, Brammer MJ (2009a) Disorder-specific dissociation of orbitofrontal dysfunction in boys with pure conduct disorder during reward and ventrolateral prefrontal dysfunction in boys with pure ADHD during sustained attention. *Am J Psychiatr* 166, 83-94.
- Rubia K, Halari R, Christakou A, Taylor E (2009b) Impulsiveness as a timing disturbance: neurocognitive abnormalities in attention-deficit hyperactivity disorder during temporal processes and normalization with methylphenidate. *Phil Transac R Soc* 364, 1919-1931.
- Rubia K, Overmeyer S, Taylor E, Brammer M, Williams SC, Simmons A, Andrews C, Bullmore ET (1999) Hypofrontality in attention deficit hyperactivity disorder during higher-order motor control: a study with functional MRI. *Am J Psychiatr* 156, 891-896.
- Rubia K, Smith AB, Taylor E, Brammer MJ (2007) Linear age-correlated functional development of right inferior fronto-striato-cerebellar networks during response inhibition and anterior cingulate during error-related processes. *Hum Brain Mapp* 28, 1163-1177.
- Rubia K, Taylor E, Smith H, Oksannen H, Overmeyer S, Newman S (2001) Neuropsychological analyses of impulsiveness in childhood hyperactivity. *Br J Psychiatr* 179, 138-143.
- Rubia K, Smith A (2004) The neural correlates of cognitive time management. *Acta Neurobiol Exp* 64, 329-340.
- Ruchow M, Groen G, Kiefer M, Hermle L, Spitzer M, Falkenstein M (2008) Impulsiveness and ERP components in a Go/No go task. *J Neural Transm* 115, 909-915.
- Rüsch N, Schulz D, Valerius G, Steil R, Bohus M, Schmahl C (2011) Disgust and implicit self-concept in women with borderline personality disorder and posttraumatic stress disorder. *Eur Arch Psychiatry Clin Neurosci* 261, 369-376.
- Rustichini A (2005) Emotion and reasoning in making decisions. *Science* 310, 1624-1625.

- Sasayama D, Hayashida A, Yamasue H, Harada Y, Kaneko T, Kasai K, Washizuka S, Amano N (2010) Neuroanatomical correlates of attention-deficit-hyperactivity disorder accounting for comorbid oppositional defiant disorder and conduct disorder. *Psychiatry Clin Neurosci* 64, 394-402.
- Scahill L (2009) Alpha-2 adrenergic agonists in children with inattention, hyperactivity and impulsiveness. *CNS Drugs* 23 Suppl 1, 43-49.
- Scheres A, Hamaker EL (2010) What we can and cannot conclude about the relationship between steep temporal reward discounting and hyperactivity-impulsivity symptoms in attention-deficit/hyperactivity disorder. *Biol Psychiatry* 68, 17-18.
- Scheres A, Dijkstra M, Ainslie E, Balkan J, Reynolds B, Sonuga-Barke E, Castellanos FX (2006) Temporal and probabilistic discounting of rewards in children and adolescents: effects of age and ADHD symptoms. *Neuropsychologia* 44, 2092-2103.
- Scheres A, Lee A, Sumiya M (2008) Temporal reward discounting and ADHD: task and symptom specific effects. *J Neural Transm* 115, 221-226.
- Scheres A, Milham MP, Knutson B, Castellanos FX (2007) Ventral striatal hypo-responsiveness during reward anticipation in attention-deficit/hyperactivity disorder. *Biol Psychiatry* 61, 720-724.
- Scheres A, Sumiya M, Thoeny AL (2010) Studying the relation between temporal reward discounting tasks used in populations with ADHD: a factor analysis. *Int J Methods Psychiatr Res* 19, 167-176.
- Scheres A, Tontsch C, Thoeny AL, Kaczurkin A (2010) Temporal reward discounting in attention-deficit/hyperactivity disorder: the contribution of symptom domains, reward magnitude, and session length. *Biol Psychiatry* 67, 641-648.
- Schmahl C, Berne K, Krause A, Kleindienst N, Valerius G, Vermetten E, Bohus M (2009) Hippocampus and amygdala volumes in patients with borderline personality disorder with or without posttraumatic stress disorder. *J Psychiatr Neurosci* 34, 289-295.
- Schmahl C, Bremner JD (2006) Neuroimaging in borderline personality disorder. *J Psychiatr Res* 40, 419-427.
- Schmahl C, Vermetten E, Elzinga BM, Bremner BJ (2003) Magnetic resonance imaging of hippocampal and amygdala volume in women with childhood abuse and borderline personality disorder. *Psychiatr Res* 122, 193-198.
- Schneider MF, Krick CM, Retz W, Henges G, Retz-Junginger P, Reith W, Rösler M (2010) Impairment of fronto-striatal and parietal cerebral networks correlates with attention deficit hyperactivity disorder (ADHD) psychopathology in adults - a functional magnetic resonance imaging (fMRI) study. *Psychiatry Res* 183, 75-84.
- Schumann G, Loth E, Banaschewski T, Barbot A, Barker G, Böchel C, Conrod PJ, Dalley JW, Flor H, et al (2010) The IMAGEN study: reinforcement-related behaviour in normal brain function and psychopathology. *Molec Psychiatr* 15, 1128-1139.
- Semrud-Clikeman M, Pliszka SR, Lancaster J, Liotti M (2006) Volumetric MRI differences in treatment-naïve vs chronically treated children with ADHD. *Neurology* 67, 1023-1027.
- Seri Y, Kofman O, Shay L (2002) Time estimation could be impaired in male, but not female adults with attention deficits. *Brain Cogn* 48, 553-558.
- Sescousse G, Redouté J, Dreher JC (2010) The architecture of reward value coding in the human orbitofrontal cortex. *J Neurosci* 30, 13095-13104.
- Sher KJ, Trull TJ (1994) Personality and disinhibitory psychopathology: alcoholism and antisocial personality disorder. *J Abnormal Psychol* 103, 92-102.

- Sheridan MA, Hinshaw S, D'Esposito M (2010) Stimulant medication and prefrontal functional connectivity during working memory in ADHD: a preliminary report. *J Atten Disord* 14, 69-78.
- Shiva A, Haden SC, Brooks J (2009a) Forensic and civil psychiatric inpatients: development of the inpatient satisfaction questionnaire. *J Am Acad Psychiatry Law* 37, 201-213.
- Shiva A, Haden SC, Brooks J (2009b) Psychiatric civil and forensic inpatient satisfaction with care: the impact of provider and recipient characteristics. *Soc Psychiatry Psychiatr Epidemiol* 44, 979-987.
- Smith AB, Taylor E, Brammer M, Halari R, Rubia K (2008) Reduced activation in right lateral prefrontal cortex and anterior cingulate gyrus in medication-naïve adolescents with attention deficit hyperactivity disorder during time discrimination. *J Child Psychol Psychiatr* 48, 881-889.
- Soloff P, Nutche J, Goradia D, Diwadkar V (2008) Structural brain abnormalities in borderline personality disorder: a voxel-based morphometry study. *Psychiatry Res* 164, 223-236.
- Sonuga-Barke EJ (2002) Psychological heterogeneity in AD/HD – a dual pathway model of behaviour and cognition. *Behav Brain Res* 130, 29-36.
- Sonuga-Barke EJ (2003) The dual pathway model of AD/HD: an elaboration of neurodevelopmental characteristics. *Neurosci Biobehav Rev* 27, 593-604.
- Sonuga-Barke EJ, Dalen L, Remington B (2003) Do executive deficits and delay aversion make independent contributions to preschool attention-deficit/hyperactivity disorder symptoms? *J Am Acad Child Adolesc Psychiatry* 42, 1335-1342.
- Sonuga-Barke EJ, Taylor E, Sembi S, Smith J (1992) Hyperactivity and delay aversion – I. *J Child Psychol Psychiatr* 33, 387-398.
- Sripada CS, Gonzalez R, Luan Phan K, Liberzon I (2011) The neural correlates of intertemporal decision-making: Contributions of subjective value, stimulus type, and trait impulsivity. *Hum Brain Mapp* 32, 1637-1648.
- Stein MB, Koverola C, Hanna C, Torchia MG, McClarty B (1997) Hippocampal volume in women victimized by childhood sexual abuse. *Psychol Med* 27, 951-959.
- Takahashi T, Chanen AM, Wood SJ, Yücel M, Tanino R, Suzuki M, Velakoulis D, Pantelis C, McGorry PD (2009) Insular cortex volume and impulsivity in teenagers with first-presentation borderline personality disorder. *Prog Neuropsychopharmacol Biol Psychiatry* 33, 1395-1400.
- Tamm L, Menon V, Ringel J, Reiss AL (2004) Event-related fMRI evidence of frontotemporal involvement in aberrant response inhibition and task switching in attention-deficit/hyperactivity disorder. *J Am Acad Child Adolesc Psychiatry* 43, 1430-1440.
- Tebartz van Elst L, Hesslinger B, Thiel T, Geiger E, Haegele K, Lemieux L, Lieb K, Bohus M, Hennig J, Ebert D (2003) Frontolimbic brain abnormalities in patients with borderline personality disorder: a volumetric magnetic resonance imaging study. *Biol Psychiatry* 54, 163-171.
- Terry P, Doumas M, Desai RI, Wing AM (2009) Dissociations between motor timing, motor coordination, and time perception after the administration of alcohol or caffeine. *Psychopharmacology* 202, 719-729.
- Toplak ME, Dockstader C, Tannock R (2006) Temporal information processing in ADHD: findings to date and new methods. *J Neurosci Methods* 151, 15-29.

- Valera EM, Spencer RMC, Zeffiro TA, Makris N, Spencer TJ, Faraone SV, Biederman J, Seidman LJ (2010) Neural substrates of impaired sensorimotor timing in adult attention-deficit/hyperactivity disorder. *Biol Psychiatry* 68, 359-367.
- Valko L, Schneider G, Doehnert M, Möller U, Brandels D, Steinhausen H-C, Drechsler R (2010) Time processing in children and adults with ADHD. *J Neural Transm* 117, 1213-1228.
- Vieregge P, Heberlein I, Kömpf D (1997) Are neuropsychological tests useful in screening for the genetic risk of Parkinson's disease? *Parkinsonism Relat Disord* 3, 141-150.
- Völlm B, Richardson P, Stirling J, Elliott R, Dolan M, Chaudhry I, Del Ben C, McKie S, Anderson I, Deakin B (2004) Neurobiological substrates of antisocial and borderline personality disorder: preliminary results of a functional fMRI study. *Crim Behav Ment Health* 14, 39-54.
- Völlm B, Richardson P, McKie S, Elliott R, Dolan M, Deakin B (2007) Neuronal correlates of reward and loss in cluster B personality disorders: a functional magnetic resonance imaging study. *Psychiatr Res: Neuroimaging* 156,151-167.
- Wiener M, Turkeltaub P, Coslett HB (2010) The image of time: a voxel-wise meta-analysis. *Neuroimage* 49, 1728-1740.
- White HR, Marmorstein NR, Crews FT, Bates ME, Mun E-Y, Loeber R (2011) Associations between heavy drinking and changes in impulsive behaviour among adolescent boys. *Alcohol Clin Exp Res* 35, 1-9.
- Whittle S, Chanen AM, Fornito A, McGorry PD, Pantelis C, Yücel M (2009) Anterior cingulate volume in adolescents with first-presentation borderline personality disorder. *Psychiatry Res* 172, 155-160.
- Wilens TE, Spencer TJ (2010) Understanding attention-deficit/hyperactivity disorder from childhood to adulthood. *Postgrad Med* 122, 97-109.
- Wingenfeld K, Spitzer C, Rullkötter N, Löwe B (2010) Borderline personality disorder: hypothalamus pituitary adrenal axis and findings from neuroimaging studies. *Psychoneuroendocrinology* 35, 154-170.
- Wolf RC, Plichta MM, Sambataro F, Fallgatter AJ, Jacob C, Lesch K-P, Hermann MJ, Schönfeldt-Lecuona C, Connemann BJ, Grön G, Vasic N (2009) Regional brain activation changes and abnormal functional connectivity of the ventrolateral prefrontal cortex during working memory processing in adults with attention-deficit/hyperactivity disorder. *Hum Brain Mapp* 30, 2252-2266.
- Woolverton WL, Myerson J, Green L (2007) Delay discounting of cocaine by rhesus monkeys. *Exp Clin Psychopharmacol* 15, 238-244.
- Zanarini MC, Frankenburg FR, Dubo ED, Sickel AE, Trikha A, Levin A, Reynolds V (1998a) Axis II comorbidity of borderline personality disorder. *Comprehen Psychiatr* 39, 296-302.
- Zanarini MC, Frankenburg FR, Dubo ED, Sickel AE, Trikha A, Levin A, Reynolds V (1998b) Axis I comorbidity of borderline personality disorder. *Am J Psychiatr* 155, 1733-1739.
- Zapolski TC, Cyders MA, Smith GT (2009) Positive urgency predicts illegal drug use and risky sexual behaviour. *Psychol Addict Behav* 23, 348-354.
- Zetsche T, Frodl T, Preuss UW, Schmitt G, Seifert D, Leinsinger G, Born C, Reiser M, Möller HJ, Meisenzahl EM (2006) Amygdala volume and depressive symptoms in patients with borderline personality disorder. *Biol Psychiatry* 60, 302-310.
- Zetsche T, Preuss UW, Frodl T, Schmitt G, Seifert D, Münchhausen E, Tabrizi S, Leinsinger G, Born C, Reiser M, Möller HJ, Meisenzahl EM (2007) Hippocampal volume

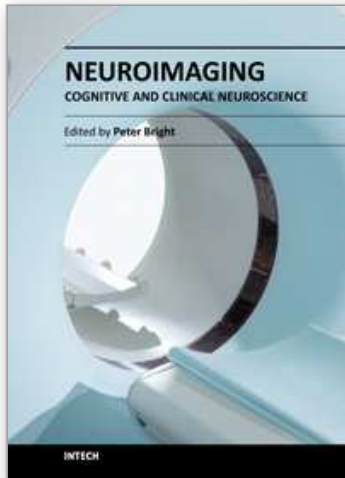


reduction and history of aggressive behaviour in patients with borderline personality disorder. *Psychiatry Res* 154, 157-170.

Zimmermann M, Mattia JJ (1999) Axis I diagnostic comorbidity and borderline personality disorder. *Compr Psychiatry* 40, 245-252.

Zlotnick C, Johnson DM, Yen S, Battle CL, Sanislow CA, Skodol AE, Grilo CM, McGlashan TH, Gunderson JG, Bender DS, Zanarini MC, Shea MT (2003) Clinical features and impairment in women with Borderline Personality Disorder (BPD) with Posttraumatic Stress Disorder (PTSD), BPD without PTSD, and other personality disorders with PTSD. *J Nerv Ment Dis* 191, 706-713.

IntechOpen



## **Neuroimaging - Cognitive and Clinical Neuroscience**

Edited by Prof. Peter Bright

ISBN 978-953-51-0606-7

Hard cover, 462 pages

**Publisher** InTech

**Published online** 16, May, 2012

**Published in print edition** May, 2012

The rate of technological progress is encouraging increasingly sophisticated lines of enquiry in cognitive neuroscience and shows no sign of slowing down in the foreseeable future. Nevertheless, it is unlikely that even the strongest advocates of the cognitive neuroscience approach would maintain that advances in cognitive theory have kept in step with methods-based developments. There are several candidate reasons for the failure of neuroimaging studies to convincingly resolve many of the most important theoretical debates in the literature. For example, a significant proportion of published functional magnetic resonance imaging (fMRI) studies are not well grounded in cognitive theory, and this represents a step away from the traditional approach in experimental psychology of methodically and systematically building on (or chipping away at) existing theoretical models using tried and tested methods. Unless the experimental study design is set up within a clearly defined theoretical framework, any inferences that are drawn are unlikely to be accepted as anything other than speculative. A second, more fundamental issue is whether neuroimaging data alone can address how cognitive functions operate (far more interesting to the cognitive scientist than establishing the neuroanatomical coordinates of a given function - the where question).

### **How to reference**

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Trevor Archer and Peter Bright (2012). Functional and Structural MRI Studies on Impulsiveness: Attention-Deficit/Hyperactive Disorder and Borderline Personality Disorders, *Neuroimaging - Cognitive and Clinical Neuroscience*, Prof. Peter Bright (Ed.), ISBN: 978-953-51-0606-7, InTech, Available from: <http://www.intechopen.com/books/neuroimaging-cognitive-and-clinical-neuroscience/functional-mri-studies-on-impulsiveness>

**INTECH**  
open science | open minds

### **InTech Europe**

University Campus STeP Ri  
Slavka Krautzeka 83/A  
51000 Rijeka, Croatia  
Phone: +385 (51) 770 447  
Fax: +385 (51) 686 166  
[www.intechopen.com](http://www.intechopen.com)

### **InTech China**

Unit 405, Office Block, Hotel Equatorial Shanghai  
No.65, Yan An Road (West), Shanghai, 200040, China  
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元  
Phone: +86-21-62489820  
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen