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Short communication

Altered executive function in obesity. Exploration of the role of affective states on cognitive abilities

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ABSTRACT

There is a growing evidence that obesity is not only a weight problem, but it is linked to adverse neurocognitive outcomes. Besides obesity, frontal lobe based cognitive deficits in depressed patients are confirmed, and interactions between depression and obesity are known. In our study we investigated the relationship between cognitive functioning, mood and female obesity. Our findings revealed reduced mental flexibility and sustained attention capacity in obesity together with the presence of depressive mood. The mediating role of depression is confirmed. Positive emotion was associated with cognitive functions independently from BMI. Positive affectivity in obesity treatment is discussed.

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Introduction

Executive functioning is responsible for transmissions between the inside world and environmental challenges, as well as for adjusting human behaviour in a flexible way to situations which require individuals to overcome a strong habitual response or to resist temptation (Norman & Shallice, 1980/2000). Different executive functions may include: cognitive control, the ability to sustain or flexibly redirect attention, the inhibition of inappropriate behavioural responses, initiation and execution of strategies, and the ability to flexibly switch among strategies (Robbins, 1998). People with obesity report that they feel they fail to resist food as a temptation and also report difficulties in controling aspects of their own lives (Gionta, 1995). Indeed, there is a growing evidence that obesity is not only an increased calorie intake and weight management problem, but it is linked to adverse neurocognitive outcomes, including reduced cognitive functioning, specifically frontal lobe based executive functions (Gunstad et al., 2007). Consistent with this notion and supporting the idea of a deficit of executive function in obese individuals, obese children evidence more impulsivity, lack of cognitive control, mental inflexibility and perseverence (Braet, Claus, Verbeken, & van Vlierberghe, 2007; Cserjesi, Luminet, Molnar, & Lenard, 2007). In adults, obesity was associated with poorer cognitive performance, independently from age and endocrinology factors, namely hypertension and diabetes (Cournot et al., 2006; Elias, Elias, Sullivan, Wolf, & D'Agostino, 2003). Apart from the cognitive dysfunctions, several studies have shown that obesity and depression frequently are linked together (Annunziato & Lowe, 2007; Friedman, Reichmann, Costanzo, & Musante, 2002). For the most part, obesity and depression have been compartmentalized as a separate health problem of physical and emotional natures. However, depression and obesity have shared symptoms such as sleep problems, changed appetite and dysregulated food intake (Reeves, Postolache, & Snitker, 2008).

It has been also found that depressive status (both clinical and subclinical) have a major impact on executive functions and on sustained attention (Holmes & Pizzagalli, 2007; Weiland-Fiedler et al., 2004). Denckla (1994) reported that anxiety and depression can mimic executive dysfunction, causing a sort of disconnection in the frontal lobes based executive function from other brain functions. Besides the several medical and psychological interests based studies, the relationship between obesity, executive dysfunctions and depressive status has not yet been investigated.

Our main aim was to investigate how the possible cognitive impairments on executive functions and emotional status, namely depression, anxiety and positive versus negative affectivity relate to adult obesity. We presume that executive function deficits in obesity are mediated by the frequently reported negative emotional status such as depression. Therefore, in the present study we compared the cognitive performance of adults with

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obesity and normal body weight controls on neuropsychological tasks. Furthermore, the role of emotional state and their potential impacts on executive functions has been investigated.

Participants

Participants were 30 female patients (M age = 48.8, SD ± 11; M BMI = 34.2, SD ± 3.8) with a diagnosis of obesity seeking surgical intervention for weight loss (Lap band surgery) in specialized clinics. The diagnosis was done by endocrinologists and physicians before admitting patients to the clinic. Apart from nutrition behaviour and tendencies to over-eat, no sudden hormonal changes or metabolic illness or any kind of genetic disease could explain the obesity. Thirty females with normal body weight (M age = 49.3, SD ± 11; M BMI = 22.8, SD ± 1.7) and with no diagnosis of any eating disorders or major psychiatric disorder served as control subjects. Control females were recruited by taking into account the age, education level of the patients (number of years completed in school) and their social status (current profession). There was no difference in groups for age ($t(60) = 0.06$, $p = 0.855$), education level ($t(60) = 0.03$, $p = 0.911$), social status ($t(60) = 0.14$, $p = 0.825$), while body weight ($t(60) = 20.94$, $p < 0.001$) and BMI ($t(60) = 22.05$, $p < 0.001$) showed significant differences. All participants were born in Belgium, and their native language was French. Examinations were performed in accordance with institutional and international (Declaration in Helsinki, 1964; European Union Council Directive 86/609/EEC) ethical standards. Prior to their inclusion into the study, participants gave their informal consent and written permission of participants was documented.

Materials

Beck Depression Inventory II (BDI) is a 21 item self-report inventory measuring characteristic attitudes and symptoms of depression (Beck, Steer, Ball, & Ranieri, 1996). Each item is rated on a 4-point scale and the total score is computed by summing each item (range 0–63). Mild to moderate depression corresponds to 10–18, moderate to severe depression to 19–29 and severe depression to 30–63 score ranges.

State-Trait Anxiety Inventory (STAI) is a self-rating measure of anxiety and it consists of two parts: the STAI-STATE describing the actual situation and the STAI-TRAIT general measure of anxiety (Spielberger, 1983). Participants indicated their degree of approval on the items on a 4-point Likert scale. Possible scores range from 20 to 80 for each form.

Positive Affectivity and Negative Affectivity Schedule (PANAS) is a self-rating measure of positive and negative mood state (Watson, Clark, & Tellegen, 1988). It consists of the 10 items for Positive Affectivity Schedule (PA) and 10 items for Negative Affectivity Schedule (NA). Participants indicated their degree of approval on 20 items on a 5-point scale ranging from 1 (not at all) to 5 (extremely).

Digit span memory test (DS) is a verbal measure of immediate memory (forward) and working memory (backward) maintenance and manipulation (Wechsler, 1997).

The *Semantic and Phonetic Verbal fluency* (Benton, 1968; Milner, 1964) test is used to detect spontaneous verbal flexibility and inhibition. The ability to generate verbal responses according to several rules (i.e., semantic or phonemic categories) is linked to the PFC function (Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1998). The test score was the number of correct words pronounced in one minute.

The D2 attention endurance test (D2) was chosen to measure attention capacity, concentration ability and attention distractibility (Brickenkamp, 1981).

The Trail Making Test (TMT) consists of two parts: the TMT A and the TMT B (Reitan, 1958). Performance on test A requires a basic level of concentration, and visuomotor tracking. Test B measures perceptuomotor speed and inhibition. Thus, poor performance on completion time and performance errors of the B-A may reflect difficulties in shifting capacity (Waldstein, Snow, & Muldoon, 1998).

Hayling Sentence Completion task (Burgess & Shallice, 1997) is a neuropsychological test of executive function focusing on response initiation and response suppression. It consists of two sets (A and B), and it measures executive functioning through the speed (completion time) or accuracy (number of errors) of the subjects. The score of Hayling B assesses the ability to suppress, while mental flexibility is operationalized by the difference between parts A and B.

Procedure

Each participant was tested individually in an examination room by the same examiner trained in clinical neuropsychology. Before administering the test battery, they were asked to fill up the questionnaires. The examination lasted approximately 2 h; participants were free to take a short break whenever they felt tired. The MANOVAs, *t*-tests, correlations and linear regressions reported herein were computed using SPSS, version 13. In order to test our hypothesis whether the relationship between obesity and the frontal lobe dysfunctions is mediated by mood, we used the procedure of Baron and Kenny, well described in the study of Friedman et al. (2002). Baron and Kenny (1986) proposed the following criteria must be met for mediation to be possible: The independent variable (BMI) must be significantly related to the mediator (mood), the independent variable (BMI) must be significantly related to the dependent variable (frontal lobe function), the mediator (mood) must be significantly related to the dependent variable (frontal lobe function) and the dependent variable must be reduced when the mediator is included in the regression.

Results

Group comparison

ANOVAs analysis revealed significantly more depression (BDI, $F(1, 58) = 22.38$, $p < 0.001$) and state anxiety (STAI-STATE; $F(1, 58) = 10.37$, $p = 0.002$) in the obese group. In the obese group, 24 patients out of 30 reported depression (10 patients mild, 12 moderate and 2 severe depressions), while in the control group only 10 participants scored above 10 points on the BDI (9 mild and only one moderate). No significant group differences were found for the general anxiety measure (STAI-TRAIT; $F(1, 58) = 3.37$, $p = 0.071$) and for negative (NA; $F(1, 58) = 0.09$, $p = 0.765$) or positive mood state (PA; $F(1, 58) = 1.849$, $p = 0.180$). MANOVAs revealed that women with obesity performed significantly worse on the D2 attention test ($F(1, 58) = 4.145$, $p = 0.023$), and on executive function tests, such as TMT A ($F(1, 58) = 5.71$, $p = 0.019$), Hayling A ($F(1, 58) = 20.30$, $p < 0.001$), Hayling B ($F(1, 58) = 7.86$, $p = 0.005$) and Hayling BA ($F(1, 58) = 5.31$, $p = 0.017$). Considering the accuracy (i.e. number of errors) of the D2, TMT and Hayling tests, there was no difference between the two groups.

Interactions

Pearson's correlations were performed on the BMI, neuropsychological tasks, depression, affectivity and anxiety (see Table 1). The elevated BMI positively correlated with the execution time of TMTB and the Hayling B, and negatively with the attention capacity

Table 1
Intercorrelations for body mass index (BMI), executive functions and emotional states.

	BMI	TMTB	TMTBA	HB	HBA	D2	BDI	SAI	NA
BMI									
TMTB	0.25*								
TMTBA	0.18	0.90†							
HB	0.29*	0.23	0.13						
HBA	0.24	0.19	0.11	0.99†					
D2	−0.29*	−0.61†	−0.53†	−0.22	−0.18				
BDI	0.64†	0.06	−0.04	0.27*	0.24	−0.20			
SAI	0.43†	0.20	0.20	0.22	0.22	−0.21	0.63†		
NA	0.27*	0.05	0.19	−0.14	−0.13	−0.04	0.33*	0.50†	
PA	−0.13	−0.30*	−0.24	−0.12	−0.11	0.45†	−0.39†	−0.46*	−0.20

The numbers indicate the r values of the bivariate Pearson's correlations. TMTB = Trail Making Test part B; TMTBA = Trail Making Test part B-A; HB = Hayling part B; HBA = Hayling B-A; D2 = attention test; BDI = Beck Depression scale; SAI = State Anxiety Inventory; NA = negative affectivity; PA = positive affectivity.
* $p < 0.05$.
† $p < 0.01$.

(D2 test). The BMI was strongly correlated with the negative emotional status (BDI, STAI, NA). In contrary to our presumption, the negative emotional status did not correlate with the sustained attentions. The depression correlated positively with TMT B test. There was a positive correlation between positive affectivity scores (PA) and the performance on the D2 attention task, while PA negatively correlated with TMT B. Positive correlation have been found also between positive affectivity scores (PA) and the semantic verbal fluency task ($r = 0.26$, $p = 0.052$); PA and Digit Span backward ($r = 0.42$, $p < 0.001$). However, these results were not included in Table 1 because of their not significant group differences.

Based on the correlation's results for the different factors, two sets of regressions were carried out: 1. set of regression to test whether the relationship between frontal lobe functions (Hayling B and BA) and obesity (BMI) is mediated by depression (BDI), 2. set of regression to test whether the relationship between obesity and sustained attention (D2) is mediated by positive emotional state (PA). When depression (mediator) was regressed on the BMI (dependent variable) in the first equation, the BMI was significantly associated with depression ($\beta = 0.644$, $p < 0.001$). When the dependent variables (Hayling test) were regressed on the BMI as a second equation, the Hayling B was significantly associated with BMI ($\beta = 0.29$, $p = 0.025$), while the Hayling BA was not significant with BMI ($\beta = 0.23$, $p = 0.065$). In the third equation depression was regressed on the Hayling test, and depression was significantly related to Hayling B ($\beta = 0.28$, $p = 0.035$), while the relationship between Hayling BA and depression was not significant ($\beta = 0.23$, $p = 0.065$). When both BMI and depression were regressed on Hayling B test, the regression for BMI was reduced when depression was entered as a mediating variable in the regression ($\beta = 0.19$, $p = 0.245$). Thus, each of the criteria outlined by Baron and Kenny for mediation was met only for the Hayling B, which model is presented in Fig. 1.

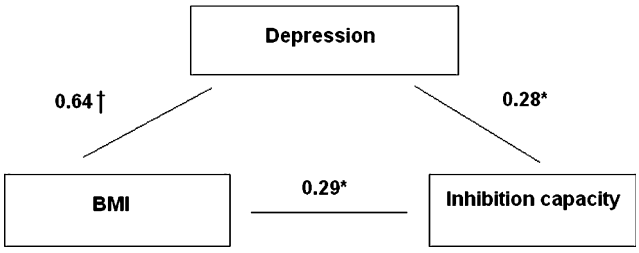

Fig. 1. Regression model on the relationship between frontal lobe function (inhibition capacity) and obesity mediated by depression (BDI). The numbers indicate β values, the effect of the predictor when the mediator is in the model. (*) $p < 0.05$ and (†) $p < 0.01$.

In the second model, positive affectivity scores (mediator) were regressed on the BMI (dependent variable), the BMI was not associated significantly with positive affectivity ($\beta = -0.134$, $p = 0.301$). When the dependent variables (D2 test) were regressed on the BMI, the D2 test was significantly associated with BMI ($\beta = -0.281$, $p = 0.027$). Then, positive affectivity was regressed on the D2 attention test, and positive affectivity was significantly related to D2 ($\beta = 0.453$, $p < 0.001$). When both BMI and positive affectivity were regressed on D2 test, instead of decreasing, the regression for BMI was increased when positive affectivity was entered as a mediating variable in the regression ($\beta = 0.418$, $p < 0.001$). Therefore, our results did not confirm the mediation effect of the positive affect on the relationship between BMI and the performance on D2 attention test.

Discussion

In this study we were interested in whether adult obesity can be characterized by any specific deficit of executive functioning and furthermore the relationship between different emotional state and performance on neuropsychological tasks. When addressing the first question about the existence of possible deficits in the different executive functions, the overall answer is that despite similar education level and social status, women with obesity performed significantly worse on the D2 attention endurance test (sustained attention) and the Hayling task (verbal mental flexibility and inhibition capacity). These findings suggest that problem in the sustaining attention and mental inflexibility due to altered inhibition capacity is associated with adult obesity. These results are in line with previous findings on both childhood (Braet et al., 2007; Cserjesi et al., 2007) and adult obesity (Elias et al., 2003; Gunstad et al., 2007) and they confirm the role of deficits in executive functioning in obesity.

However, until now the role of the negative emotional status, namely depression and anxiety, was not considered as a possible factor influencing the cognitive performance in obesity. Clinical observation often reveals that depressed patients frequently complain of distractibility and inability to handle multiple ongoing activities. Several previous studies have confirmed the existence of the deficits in attention and executive functions in major depression, however, it seems that only executive functions were associated with the severity of depression (Paelecke-Habermann, Pohl, & Leplow, 2005; Weiland-Fiedler et al., 2004).

Therefore, secondly we investigated the relationship between negative-positive affectivity, anxiety, depression and cognitive performance. Our results reinforced the link between the depression and adult obesity. Our first regression model (see Fig. 1) confirmed the mediating role of the depression (Rogers, Kasai, & Koji, 2004; Weiland-Fiedler et al., 2004) in the relationship

between inhibition capacity (Hayling B, executive functioning) and obesity. The mediating role of depression on the relationship between mental flexibility (Hayling BA) and obesity was not confirmed, however the β values show a tendency to be significant ($p = 0.065$). This marginal effect can be explained in two ways: First, our analyses had a lack of precision due to the low sample size. Second, previous findings showed that the deficit on executive functioning was associated with the severity of depression. In order to assess depression, we have used BDI, which is the most commonly referenced self-administered depression severity measure in both clinical practices and research. Probably self-administered inventory method was not sensitive enough for the individual differences to investigate the possible correlation with executive functioning. Apart from the significant group differences on the BDI scores, the obese group reported mostly mild or moderate depression, which still could be considered as a sub-clinical level of depression. Therefore, another possibility is that mean depression level amongst our obese participants was not high enough to have an impact on the frontal lobe based mental flexibility. This idea is reinforced by the fact that despite significantly higher depression, no general psychomotor or verbal retardation was found in the obese group. Neuropsychological studies of executive function in clinical depression have identified deficits in working memory, cognitive set-shifting and planning tasks (Rogers et al., 2004). In fact, diminished ability to concentrate, indecisiveness and psychomotor retardation (e.g., slowed speech and thinking) are included among the key diagnostic criteria for clinical depression (DSM-IV, 2000).

Reduced sustained attentional capacity did not correlate with depression in obesity. We have found that positive affectivity was correlated with most of the neuropsychological tasks together with the D2 attention task (e.g. D2 attention test, verbal fluency, digit span backward and TMT) in both obese and control groups.

Williams et al. (2002) have found that dieting was associated with deficits in sustained attention. As our patient group was under medically imposed diets, dieting can be an appropriate answer for the attentional problem on D2 test. Eating is a highly motivated and reinforced behaviour, the reward/non-punishment or punishment/omission of rewards is used to regulate this behaviour (Gray, 1987). Davis, Levitan, Muglia, Bewell, and Kennedy (2004) showed higher sensitivity to immediate rewards in overweight and obese adult women. Obese individuals' difficulties in inhibiting or modifying current behaviours, sustained attention and less appropriate cognitive control, can be related to the lack of positive emotional state (reward). Cognitive studies reported that induced positive mood facilitates information processing, when creativity and mental flexibility were required (Gasper & Clore, 2002; Isen, 1987). Mental flexibility, creative thinking and the ability to "think outside the box" are very important capacities in the everyday life, they are necessary to be able to change unhealthy life style or to resolve personal problems by looking for different alternatives.

Kaplan (2001) proposed that when people are required to focus their attention and put forth sustained cognitive effort (e.g. dieting), it may lead to mental fatigue. In turn, this may result in irritability, anxiety, anger, frustration, mental and physical fatigue, and may further diminish the ability to successfully perform cognitive tasks and address social demands (Kuo & Sullivan, 2001). Mental restoration is commonly considered a reversal of these effects, allowing for increased critical thinking, concentration and sustained focus (Kaplan, 2001).

One limitation of our study should be discussed. Consistent with the past literature, we interpreted and presented obesity in this study as a consequence of pathologically elevated BMI. However, recent studies reported two different types of obese groups: the emotional eaters (e.g. binge-eaters) and "stabile" obese people. Pinaquy, Chabrol, Simon, Louvet, and Barbe (2003) indicated that obese women who have difficulty identifying and communicating their feelings have a tendency to eat in response to emotions, specifically negative emotions. Williams et al. (2002) suggested that different aspects of eating behaviours have dissociable effects on cognitive-affective function. In the future studies the existence of these two obese subgroups should be taken into account when the role of affective states on neurocognitive functions will be investigated.

In summary, this study supports the idea that the deficit in executive functions – specifically, sustained attention, lack of control, and depression – are linked to the state of obesity. Importantly, our results showed that positive affectivity facilitates the cognitive capacities. Therefore, the treatment of depression, and the facilitating effect of positive emotions in the improvement of cognitive control should be integrated in the clinical practices. In this manner, healthcare providers can work to treat both conditions (affective problems and obesity) together, rather than obesity in isolation.

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References

Annunziato, R. A., & Lowe, M. R. (2007). Taking action to lose weight: toward an understanding of individual differences. *Eating Behaviour, 8*(2), 185–194.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. F. (1996). Comparison of Beck Depression Inventories -IA and -II in psychiatric outpatients. *Journal of Personality Assessment, 67*(3), 588–597.

Benton, A. L. (1968). Differential behavioral effects in frontal lobe disease. *Neuropsychologia, 6*, 53–60.

Braet, C., Claus, L., Verbeken, S., & van Vlierberghe, L. (2007). Impulsivity in overweight children. *European Child & Adolescence Psychiatry, 16*(8), 473–483.

Brickenkamp, R. (1981). *Test d2 Aufmerksamkeits-Belastungs-Test* (7th ed.). Göttingen: Verlag für Psychologie (Hogrefe).

Burgess, P., & Shallice, T. (1997). *The Hayling and Brixton Tests. Test manual*. Bury St Edmunds, UK: Thames Valley Test Company.

Cournot, M., Marquie, J. C., Ansiau, D., Martinaud, C., Fonds, H., Ferrières, J., et al. (2006). Relation between body mass index and cognitive function in healthy middle-aged men and women. *Neurology, 67*, 1208–1214.

Cserjesi, R., Luminet, O., Molnar, D., & Lenard, L. (2007). Is there any relationship between obesity and mental flexibilty in cildren? *Appetite, 49*, 675–678.

Davis, C., Levitan, R. D., Muglia, P., Bewell, C., & Kennedy, J. L. (2004). Decision-making deficits and overeating: a risk model for obesity. *Obesity Research, 12*(6), 929–935.

Denckla, M. B. (1994). Measurement of executive functioning. In G. R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities: new views on measurement issues* (pp. 117–142). Baltimore: Paul H. Brookes Publishing Company.

Diagnostic and Statistical Manual of Mental Disorders. (2000). Fourth edition—text revision. American Psychiatric Association.

Elias, M. F., Elias, P. K., Sullivan, L. M., Wolf, P. A., & D'Agostino, R. B. (2003). Lower cognitive function in the presence of obesity and hypertension: the Framingham heart study. *International Journal of Obesity, 27*, 260–268.

Friedman, K. F., Reichmann, S. K., Costanzo, P. R., & Musante, G. J. (2002). Body image partially mediates the relationship between obesity and psychological distress. *Obesity Research, 10*, 33–41.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture mood and global vs. local processing of visual information. *Psychological Science, 13*, 34–40.

Gionta, D. (1995). Food addiction. *American Health, 14*, 52–56.

Gray, J. A. (1987). *The psychology of fear and stress*. Cambridge: Cambridge University Press.

Gunstad, J., Paul, R. H., Cohen, R. A., Tate, D. F., Spitznagel, M. B., & Gordon, E. (2007). Elevated body mass index is associated with executive dysfunction in otherwise healthy adults. *Comprehensive Psychiatry, 48*, 57–61.

Holmes, A. J., & Pizzagalli, D. A. (2007). Task feedback effects on conflict monitoring and executive control: relationship to subclinical measures of depression. *Emotion, 7*(1), 68–76.

Isen, A. M. (1987). Positive affect, cognitive process, and social behaviour. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 203–253). San Diego, CA: Academic Press.

Kaplan, S. (2001). Meditation, restoration, and the management of mental fatigue. *Environment and Behavior, 33*, 480–506.
Kuo, F. E., & Sullivan, W. C. (2001). Aggression and violence in the inner city: effects of environment via mental fatigue. *Environment and Behavior, 33*(4), 543–571.
Milner, B. (1964). Some effect of frontal lobectomy in man. In J. M. Warren & D. Akert (Eds.), *Frontal granular cortex and behavior* (pp. 313–334). New York: McGraw-Hill.
Norman, D. A., & Shallice, T. (1980/2000). Attention to action: willed and automatic control of behaviour. In M. Gazzaniga (Ed.), *Cognitive neuroscience: a reader* (pp. 376–391). Oxford, UK: Blackwell.
Paelecke-Habermann, Y., Pohl, J., & Leplow, B. (2005). Attention and executive function in remitted major depression patients. *Journal of Affective Disorders, 89*(1–3), 125–135.
Pinaquy, S., Chabrol, H., Simon, Ch. , Louvet, J. P., & Barbe, P. (2003). Emotional eating, Alexithymia, and Binge eating disorder in obese women. *Obesity Research, 11*(2), 195–201.
Reeves, G. M., Postolache, T., & Snitker, T. S. (2008). Childhood obesity and depression: connection between these growing problems in growing children. *International Journal of Child Health and Human Development, 1*(2), 103–114.
Reitan, R. (1958). *Trail making test: manual for administration, scoring, and interpretation*. Bloomington: Indiana University.
Robbins, T. W. (1998). Dissociating executive functions of the prefrontal cortex. In A. C. Roberts, T. W. Robbins, & L. Weiskrantz (Eds.), *The prefrontal cortex. Executive and cognitive function* (pp. 117–131). Oxford: Oxford University Press.
Rogers, M., Kasai, A., & Koji, K. M. (2004). Executive and prefrontal dysfunction in unipolar depression: a review of neuropsychological and imaging evidence. *Neuroscience Research, 50*, 1–11.
Spielberger, C. D. (1983). *Manual for the State-Trait Anxiety Inventory (STAI)*. Palo Alto, CA: Consulting Psychologists Press.
Troyer, A. K., Moscovitch, M., Winocur, G., Alexander, M. P., & Stuss, D. (1998). Clustering and switching on verbal fluency: the effects of focal frontal- and temporal-lobe lesions. *Neuropsychologia, 36*(6), 499–504.
Waldstein, S. R., Snow, J., & Muldoon, M. F. (1998). Applications of neuropsychological assessment to the study of cardiovascular diseases. In D. S. Krantz & A. Baum (Eds.), *Technology and methods in behavioural medicine research* (pp. 69–95). Mahwah, N.J. Lawrence Erlbaum Associates.
Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070.
Wechsler, D. (1997). *WAIS-III, WMS-III, technical manual*. San Antonio: Psychological Corporation.
Weiland-Fiedler, P., Erikson, K., Waldeck, T., Luckenbaugh, D. A., Pike, D., Bonne, O., et al. (2004). Evidence for continuing neuropsychological impairments in depression. *Journal of Affective Disorders, 82*(2), 253–258.
Williams, J. M. G., Healy, H., Fade, J., Windle, G., Cowen, P. J., Green, M. W., et al. (2002). Mood, eating behaviour and attention. *Psychological Medicine, 32*, 469–481.