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AFFECT, COGNITION, AWARENESS AND BEHAVIOUR IN EATING DISORDERS.

COMPARISON BETWEEN OBESITY AND ANOREXIA NERVOSA

Doctoral (PhD) - thesis

Renáta Cserjési

Supervisors: **Prof. Dr. László Lénárd**
Prof. Olivier Luminet

Program director: **Prof. Dr. László Lénárd**
Prof. Olivier Corneille

Head of PhD School: **Prof. Dr. László Lénárd**
Prof. Vincent Yzerbyt

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The preface

All examinations presented in the frame of the current doctoral thesis are based on an official co-tutorial agreement between the University of Pécs, Medical School, Pécs, Hungary and the Catholique University of Louvain, Department of Psychology, Louvain-la-Neuve, Belgium. All the present research works were carried out under the shared supervision of Prof. Dr. László Lénárd and of Prof. Dr. Olivier Luminet.

The participants were recruited both from Belgium and Hungary and the language of the examinations was either French or Hungarian.

Examinations of the patients and the healthy controls were performed in accordance with institutional (Pécs University Medical School, Catholique University of Louvain) and international (Declaration in Helsinki, 1964; European Union Council Directive 86/609/EEC) ethical standards.

Prior to inclusion into the following studies each participant gave his/her written consent and in every case of underage participant the written permission of parents was documented.

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1. Introduction

1. 1. Obesity

"They used to call us fatty, chunky or sometimes tubby
Euphemisms like sumo, alternatively maybe chubby
However Political correctness, has demanded that this must cease
so now the doctors just call us
all clinically obese"
Paul Curtis

1. 1. 1. Definition and history

Obesity is a condition in which the natural energy reserve, stored in the fatty tissue of humans is increased to a point where it is associated with certain health conditions or increased mortality.

Obesity now is a worldwide epidemic and one of the major concerns for global health as it has been recently declared by the World Health Organization (WHO, 2000). Obesity is associated with numerous types of other medical illnesses such as type II diabetes, cardiovascular diseases, stroke, certain carcinomas and sleeping problems (NIH, 2000; Dunstan et al. 2001; Haynes, 2005; Romero-Corral, 2006).

In the past in several human cultures, plumpness was associated with physical attractiveness, strength, and fertility. Some of the earliest known cultural artefacts, known as Venus figurines (i.e. Venus from Willendorf), are pocket-sized statues representing an obese female figure. Although their cultural significance is unrecorded, their widespread use throughout pre-historic Mediterranean and European cultures suggests a central role for the obese female form in magical rituals, and suggests cultural approval of this body form (Bray, 2005). A large, well-fed body was occasionally considered a symbol of wealth, motherhood and social status in

cultures prone to food shortages or famine. But as food security was realised, it came to serve more as a visible sign of "lust for life", appetite, and immersion in the realm of the erotic. This was especially the case in the visual arts, such as the paintings of Rubens (see the picture above), who regularly used the full and abundant female figures.

Obesity can also be seen as a symbol within a system of prestige. "The kind of food, the quantity, and the manner in which it is served are among the important criteria of social classes… With the ever increasing diversity of foods, food has become not only a matter of social status, but also a mark of one's personality and taste" (Powdermaker, 1997).

In modern Western culture, the obese body shape is widely regarded as unattractive. Many negative stereotypes are commonly associated with obese people, such as the belief that they are lazy, out-of-control, greedy, less smart, or even nastier than normal body weight people (Schwartz et al., 2006).

1. 1. 2. Diagnostic and Clinical features

Overweight and Obesity are clearly defined medical classifications. Body Mass Index (BMI) is a simple and widely used method for estimating body fat. In epidemiology BMI alone is used as an indicator of prevalence and incidence. BMI was developed by the Belgian statistician and anthropometrist Adolphe Quetelet (Sheynin, 1986). It is calculated by dividing the subject's weight in kilograms by the square of his/her height in metres ($BMI = kg / m^2$) or ($BMI = weight\ (lbs.) * 703 / height\ (inches)^2$).

Table 1 The International Classification of adult underweight, overweight and obesity according to BMI (WHO, 2000)

Classification	BMI(kg/m²)
	Principal cut-off points
Underweight	<18.50
Severe thinness	<16.00
Moderate thinness	16.00 - 16.99
Mild thinness	17.00 - 18.49
Normal range	**18.50 - 24.99**
Overweight	**≥25.00**
Pre-obese	25.00 - 29.99
Obese	**≥30.00**
Obese class I	30.00 - 34-99
Obese class II	35.00 - 39.99
Obese class III	≥40.00

According to WHO, and National Institute of Health (NIH) overweight is defined by BMI higher then 25 and when BMI is reached 30 or it goes above it is considered obesity. Numerous diseases arise from being overweight or obese, and these lead to infirmities, limit the quality of life, and lower life expectancy (Wechsler et al. 2005). It must be noted that apart from these physical conditions that are high risk factors for many medical illnesses, the fat-phobia and prejudice against the overweight in the western culture is such that obese people (particularly women) tend to have a severe anxiety and depression (Friedman et al., 2002). Individuals seeking treatment for weight loss in a community sample of overweight and obese individuals appears to be motivated by psychological aspects of obesity, rather than its physical or medical consequences (Annunziato & Lowe, 2007).

Obese children, teenagers and adults face a heavy social stigma. Obese children are frequently the target of bullies that affecting badly their anyway low self-esteem (Decaluwe & Breat, 2005). Obesity in adulthood can lead to a slower rate of career advancement. Most obese people have experienced negative thoughts about their body image, and many take drastic steps to try to change their shape (Rosen et al. 1995). The two leading classificatory systems; the American Psychiatric Association (APA) the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, 1994) and World Healthy Organization (WHO) International Statistical Classification of Diseases and Related Health Problems (ICD-10, 1994) both recognise two main eating disorders, Anorexia Nervosa and Bulimia Nervosa. The

term of "Atypical Eating Disorders" denotes the remaining eating disorders such as Binge eating disorder (Fairburn & Walsh, 2005). Binge-eating disorder (BED) identifies overweight or obese patients who present with recurrent eating of unusually large amount of food during a short period of time and who do not engage in the characteristic compensatory behaviours of bulimia nervosa (Pinaquy et al. 2003).

In the DSM-IV the obesity is not an official diagnostic category. The DSM-IV diagnostic classification of *Eating Disorder Not Otherwise Specified* (EDNOS) is a residual category used for eating disorders that do not meet the criteria for specific eating disorders. Although increasingly used in clinical practice as well as in research settings, Binge-eating is part of the EDNOS (Spitzer et al., 1993): They recommend, however, that binge-eating disorder should be recognized as a disorder based on the need of further study.

1. 2. Anorexia Nervosa

"All around me are familiar faces
Worn out places, Worn out faces
Bright and early for the daily races
Going nowhere, Going nowhere
Their tears are filling up their glasses
No expression, No expression
Hide my head I want to drown my sorrow
No tomorrow, No tomorrow"
Roland Orzabal

1. 2. 1. Definition and history

Anorexia Nervosa (AN) is a condition of self initiated weight loss characterised by a profound disturbance of the body image, distorted self-perception, and obsessive fear of gaining weight, excessive physical activity and problem in emotional functioning. Individuals with anorexia often control body weight by voluntary starvation, excessive exercise, or other weight control measures, such as diet pills, diuretic or laxative drugs. The disorder primarily affects young girls in the western society and usually has its onset in adolescence. Hypotheses of an underlying psychological disturbance in young women with the disorder include conflicts

surrounding the transition from girl to a woman (Kaplan et al., 1994). It has been suggested that also psychological symptoms are related to anorexia nervosa such as feeling of helplessness and difficulty in establishing autonomy. Anorexia nervosa is a complex condition, involving psychological, neurobiological and sociological components. Anorexia Nervosa differs from Bulimia Nervosa (another eating disorder) which is characterized by a repeated cycle of bingeing followed by voluntary vomiting.

The English physician, Richard Morton, was credited with the first medical description of anorexia nervosa in 1689 (Vendereycken, 2005). But it was in a seminal report in 1873 when for the first time Sir William Gull, another English physician coined the name 'anorexia nervosa' (Silverman, 1997). This manuscript then paled into obscurity until the 19th century. Then hundred years later anorexia nervosa was first documented as an illness by modern medicine in the “L'anorexie Hysterique”, in the book of Charles Lasgue in 1973.

As examples of self-starvation appeared in the Hellenistic era when the holy anorexics abused their bodies, rejected marriage and sought religious asylum where many perished and became saints. Sadly, the idea of women suffering and dying to be thin is not an ancient phenomenon. This history of anorexia continues in Victorian times, when girls felt cultural pressure to be thin just as they do now in the 21st century. During the Victorian era, mothers and also their daughters avoided food to avoid giving off the impression that their physical appetite linked to their appetite for sex. During those times, it was commonly thought that should a woman eat more, she in turn had a greater sexual appetite (Vendereycken, 2005). Still anorexia nervosa is considered a relatively recent disorder. Although anorexia has long been well-known by psychologists and other behavioural scientists, the general public first got to know about the disease and its nature at the end of the twentieth century. The birth of this "new" disease was not only related to the new way to look at medicine, but was also an effect of the changes in the society, and on the new ideal for young women.

“I don’t care if people think is sick. Being fat is sick. It’s disgusting. All that counts is people telling me I’m skinny, or that I look like a model. Nobody cares if you’re healthy. Looking good is all that matters. Anyone who says otherwise is lying.” 14-year-old anorexic girl (Moore, 2004)

In 1978, after almost three decades of clinical experiences of anorexia, the psychologist Hilde Bruch published a book about the disease. "The Golden Cage", is

based on 70 real cases, where mostly young women's testimonials are included. During the same time as the book was published, Bruch claimed that the disease was so frequent that it had become a big problem in most American colleges and universities. Until the death of Karen Carpenter, a famous American singer of the Carpenters, in 1983, anorexia was not appeared the media. Following her death, the history of anorexia and the disease in current culture came into public discourse. Suddenly other actresses and public figures spoke out about their battles to be thin (*Kate Beckinsale- artist, Kate Moss- model, Ana Carolina Reston- model, Mary Kate Olsen –actress, Victoria Beckham- singer***,** *Nicole Richie-artist. Keira Knightley-artist etc.)*

"She starves herself to rid herself of sin
And the kick is so divine when she sees bones beneath her skin
And she says: Hey baby can you bleed like me?"
Garbage

1. 2. 2. Diagnosis and Clinical features

The most commonly used criteria for diagnosing anorexia is from the APA, DSM-IV (1994) or the ICD-10 of WHO (1994). Although biological tests can aid the diagnosis of anorexia, the diagnosis is based on a combination of behaviour, reported beliefs and experiences, and physical characteristics of the patient. Anorexia is typically diagnosed by a clinical psychologist, psychiatrist or other suitably qualified clinician. Notably, diagnostic criteria are intended to assist clinicians, and are not intended to be representative of what an individual sufferer feels or experiences in living with the illness. To be diagnosed as having anorexia nervosa, according to the DSM-IV, a person must display:

A. "Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., body weight less than 85% of that expected).

B. Intense fear of gaining weight or becoming fat, even through underweight.
C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.
D. Amenorrhea, i.e., the absence of at least three consecutive menstrual cycles.

Furthermore, the DSM-IV specifies two subtypes:

Restricting Type: During the current episode of anorexia nervosa, the person has not regularly engaged in binge-eating or purging behaviour.

Binge-Eating Type or Purging Type: During the current episode of anorexia nervosa, the person has regularly engaged in binge-eating or purging behaviour (that is, self-induced vomiting, over-exercise or the misuse of laxatives, diuretics, or enemas)."

The ICD-10 criteria are similar, but in addition, specifically mentioned the following ones:

A. "Ways that individuals might induce weight-loss or maintain low body weight (avoiding fattening foods, self-induced vomiting, self-induced purging, excessive exercise, excessive use of appetite suppressants or diuretics);
B. Physiological features, including "widespread endocrine disorder involving hypothalamic-pituitary-gonadal axis is manifest in women as amenorrhoea
C. If the onset is before puberty, development is delayed or arrested.

There are a number of features that although not necessarily diagnostic of anorexia, have been found to be commonly (but not exclusively) present in those with this eating disorder (Gowers and Bryant-Waugh, 2004). Beumont (2005) noted that the food choices of anorexia patients are characterised by unhealthy attitude and misconceptions acquired from popular magazines and dubious sources of information. As today fatty foods are considered unhealthy and low calorie vegetarian diets come into fashion, it raises negative attitudes and beliefs of people with AN towards food containing fat. Bruch (1962) proposed that AN patients have deficits in the mental representations of their own body and their body size. Rarely, there are cases when the anorexic patients have an objective opinion of their own body and

their unhealthy thinness. However, in most of the cases the patients would either hide their body shape by wearing large and long dresses or would openly and proudly demonstrate the result of their sacrifice: the slim body. Skrzypek et al (2001) suggested that body image disturbance is due to a cognitive-evaluative dissatisfaction in anorexia nervosa. In a study by Cooper & Turner (2000) conducted on anorexic patient, it was demonstrated that AN group had the highest unrealistic assumption about weight, body shape and eating compared to normal body weighted dieters and controls.

Other typical characteristics of the anorexia are the need of the control over their own life and their environment (generally their families), too much focus on the achievement, introversion, withdrawal from friendships and very low self esteem (Vandereycken and Hoek, 1991).

The model of Fairburn, Cooper and Shafran (2003) is based on the idea that eating disorders (with the exception of obesity) share some core types of psychopathology, which help maintain the eating disorder behaviour. This includes clinical perfectionism, chronic low self-esteem, mood intolerance (inability to cope appropriately with certain emotional states) and interpersonal difficulties. Figure 1 shows the model of the restrictive and the purging type of anorexia nervosa. According to this model the background mechanism of the restrictive and purging anorexia are similar, the only difference is the present of the binge eating in the purging type.

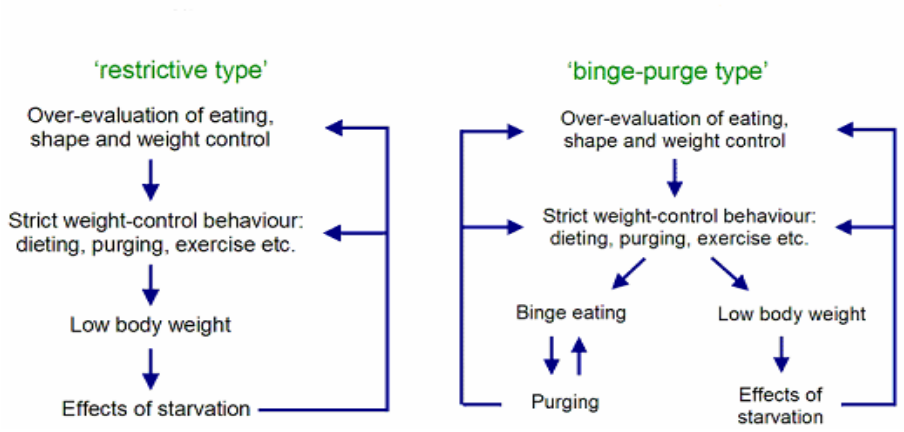
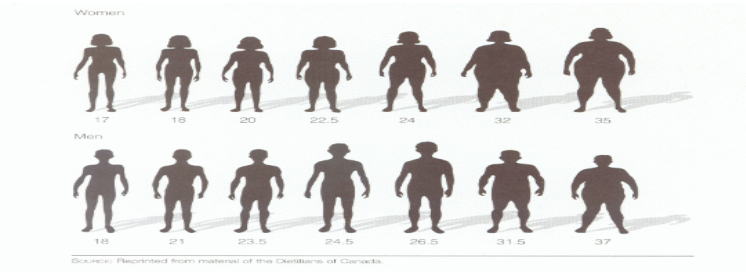


Figure 1 Model of Anorexia Nervosa (Fairburn et al., 2003)

1. 3. Epidemiology, Comorbidity, Prognosis



BMI as an indicator of a clinical condition is used in conjunction with other clinical assessments, such as waist circumference. Waist circumference is a common measure used to assess abdominal fat content. The presence of excess body fat in the abdomen, when out of proportion to total body fat, is considered an independent predictor of risk factors and ailments associated with obesity (National Institutes of Health, 1998). Men who have a waist measurement greater than 102 cm and women who have a waist measurement greater than 88 cm are at risk for cardiovascular problems. In a clinical setting, physicians take into account race, ethnicity, lean mass (muscularity), age, sex, and other factors which can affect the interpretation of BMI. BMI overestimates body fat in persons who are very muscular, and it can underestimate body fat in persons who have lost body mass (e.g. many elderly). Mild obesity as defined by BMI alone is not a cardiac risk factor, and hence BMI cannot be used as a sole clinical and epidemiological predictor of cardiovascular health. The 1999/2000 Australian Diabetes, Obesity and Lifestyle Study estimated 67% of adult men and 52% of women to be overweight or obese in 2000, or around 7 million Australian adults. 65 % of the adult American population (age 20-74) was overweight and 31 % was obese in the 2000. According to People magazine (1996): In 1972, 23 % of American women were dissatisfied with their overall appearance; in 1996, that figure has more than doubled to 48 %. An astounding 65 million people and 85 % of all female population are on diet (Gordon, 1990). Gionta (1995) estimates that the BED affects about 2 percent of the general population and that approximately 30 % of the people enrolled in weight loss programs are compulsive overeaters. Community surveys have estimated that between 2 % and 5 % of Americans experience BED in a 6-month period (Bruce & Agras, 1992). As a prognosis the short-term diet programs are seldom successful. Studies show that 85 % of dieters who do not exercise on a

regular basis regain their lost weight within two years (Stunkard, 1996). Yo-yo dieting (i.e. continuing pattern of gaining and losing weight) encourages the body to store fat and may increase the risk of heart problems. The poor dietary habits and obesity that are symptomatic of binge eating can lead to serious health problems, such as high blood pressure, heart attacks, and diabetes, if left unchecked. It appears that up to 50% of binge eating patients will stop bingeing with cognitive behavioural therapy (Brewerton, 1997).

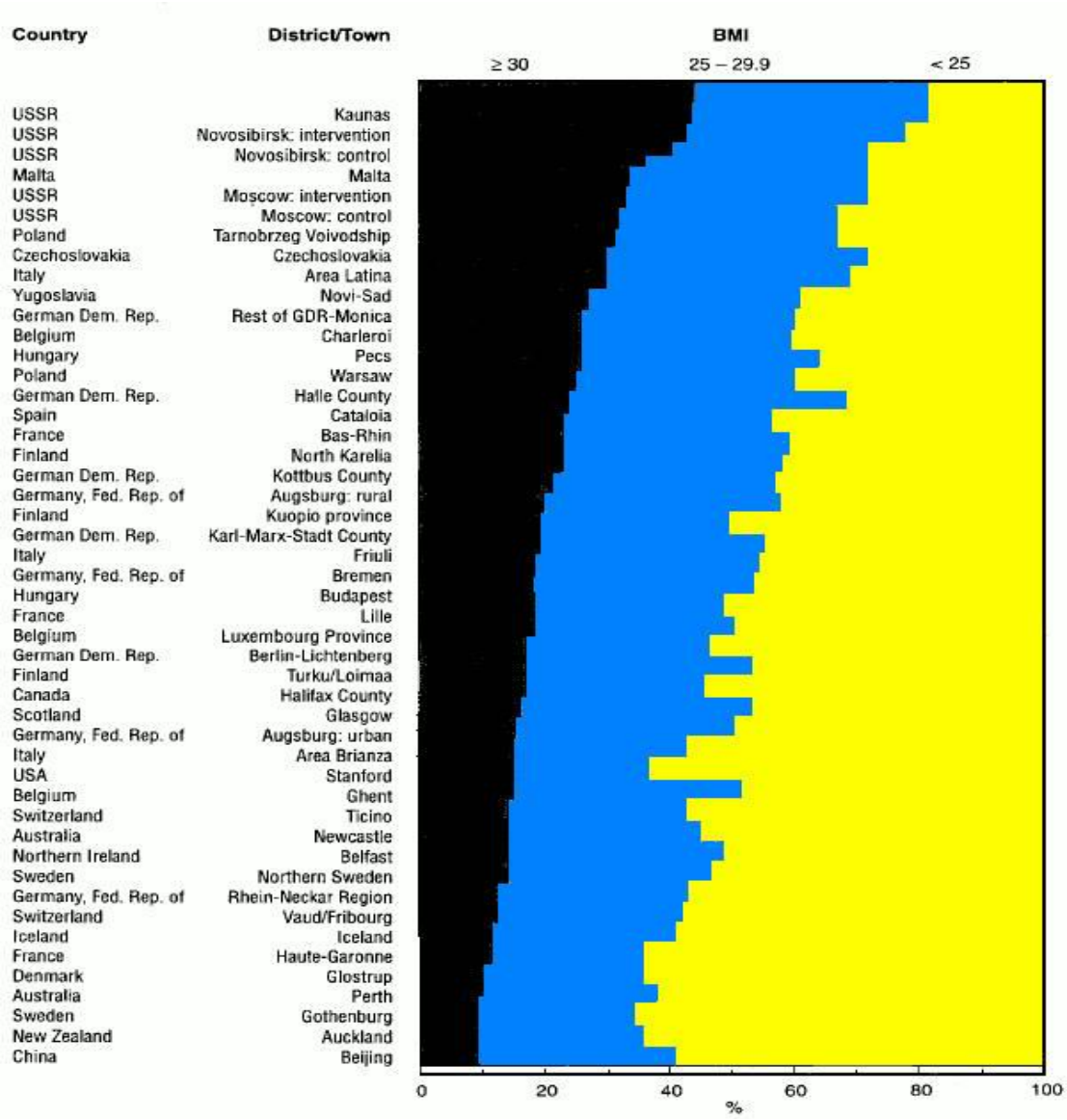


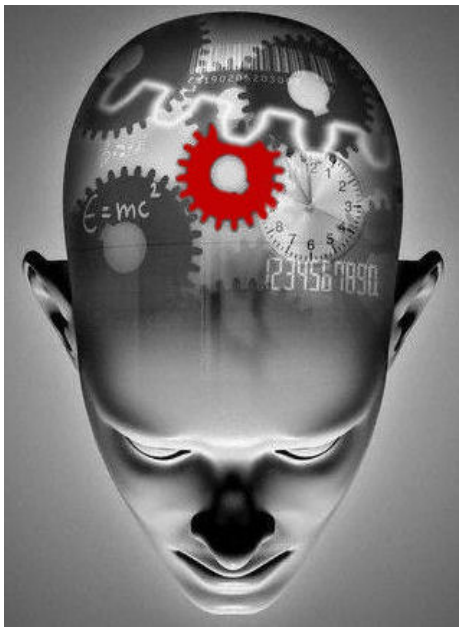
Figure 2 The proportion of women (age group 35-64) classified as obese, overweight or normal weight in 48 populations mostly in Europe of the WHO MONICA (Evans et al. 2001).

Since the early age, women are exposed to sociocultural messages about how they should behave (e.g., diet, be dependent) and look (e.g., be thin, be physically fit). Communicated through family relations, friendships, the mass media, and general developmental transitions (e.g., puberty), these sociocultural pressures increase women's risk of being dissatisfied with their bodies, experiencing negative affect (e.g., sadness, anxiety), and ultimately manifesting behavioral symptoms of disordered eating, such as extreme dieting, bingeing, and/or purging (Stice, 1992). Because these pressures are so much greater for women, prevalence rates are expected to be much higher among women than men. An estimated 0.5 to 3.7 % of females suffer from anorexia nervosa in their lifetime (APA, 2000). Approximately 90 to 95 % of all cases of anorexia nervosa occur in females, and although the disorder can appear at any age, the peak age of onset is between 12 and 18 years (Kaplan et al., 1994).

The mortality rate among people with anorexia has been assessed in 1995 at 0.56 % per year, or approximately 5.6 % per decade, which is about 12 times higher than the annual death rate due to all causes of death among females ages 15-24 in the general population (Sullivan, 1995). The studies of Harris and Barraclough (1998) and Birmingham et al. (2005) confirmed that AN is associated with one of the highest risks for premature death of all psychiatric illnesses, with approximately 10% of those who are diagnosed with the disorder eventually dying due to related causes. The most common causes of death are complications of the disorder, such as cardiac arrest or electrolyte imbalance, and suicide. The suicide rate of people with anorexia is also higher than that of the general population and is thought to be the major cause of death for those with the condition (Pompili et al. 2004). Recent findings suggested that less than one-half recover fully, one-third improve, and 10-20% remain chronically ill (Löwe et al, 2001; Steinhausen, 2002).

Part I. Models for the development of obesity and anorexia

2. Cognitive functioning



Except for a few rare metabolic disorders, weight gain or weight loss over time occurs because of the balance between energy expenditure and food intake or for both reasons (Garrow, 1995). Eating is a highly *motivated* and reinforced behaviour that induces feelings of gratification and *pleasure* (Sigal & Adler, 1976; Bonato et al.,1983).Therefore human eating behaviour is not a passive response to salient environmental triggers or merely physiological drives providing nutrients for survival; it is about *cognitive and emotional* processes based choices (Davis et al., 2004). Many people believe that eating disorders are only about food and weight issues, when in reality the eating disorder is just a symptom of underlying problems. These problems must be considered to be able to establishing a healthy eating pattern. *Food addiction*, like alcoholism, is a progressive disease that goes from pleasure to problem eating and finally to addiction, as the individual loses control over what and when to eat (Gionta, 1995). An important additional factor is that patients often lack the ability to recognize hunger and satiety (Kristensen, 2000).

People with eating disorders display reduced cognitive functioning across a range of domains including executive functioning, visual-spatial ability, attention, learning and memory (Lena et al., 2004). It seems that clinically the most relevant

deficit associated with eating disorders is related to executive function or mental flexibility (Cooper & Fairburn, 1992; Tchanturia et al. 2004).

In neuropsychology and cognitive psychology, *executive functioning* would be defined as the mental capacity to control and purposefully apply mental skills (Robbins, 1998). Executive function or cognitive control is responsible to transmit between inside world and environmental challenges and to adjust human behaviour in a flexible way to situations which require the overcoming of a strong *habitual response* or *resisting temptation* (Norman & Shallice, 1980). Different executive functions may include: the ability to sustain or flexibly redirect *attention*, the inhibition of inappropriate *behavioural or emotional* responses, the planning of strategies for future behaviour, the initiation and execution of these strategies, and the ability to flexibly switch among problem-solving strategies (Robbins, 1998). The findings of the current researches suggest that the Prefrontal Cortex (PFC) mediates the executive functioning in the human brain.

Attention can be defined as the cognitive process of the selectively concentrating on one aspect of the environment while ignoring other aspects. Attention acts as a filter on the processes of perception. Several neuroimaging findings support a role for PFC in the control of attention, and brain lesion studies also show *attentional* deficits after damage to various parts of PFC (Lebedev et al., 2004). Eating disorders are underlined by several altered cognitive functioning mostly linked to executive functions. The following two paragraphs would provide an overlook by summarising the results of current studies carried out on the relationship between eating disorders and cognitive dysfunction:

- *Obesity*: People with obesity report the sensation of failing to resist food as a temptetion and difficulty to control their own life. Obese individuals seeking treatment commonly report *compulsive overeating or binge-eating* (Hart, 1991). As the name indicates, such patients cannot resist food and they are prone to overeat, often in binges. Hernandez & Hoebel (1988) based on an animal model study presumed that overeating could be considered as *an addiction*, where food represented a natural drug. Confirming their hypothesis, it has been noted that there are similarities in underlying brain mechanisms between drug addiction and obesity (Wang et al. 2001; Volkow & Wise, 2005).

Neuropsychological studies (Hester & Garavan, 2004; Bechara, 2005) revealed that substance dependent individuals were impaired in cognitive functions; specifically executive function tasks like shifting ability and mental flexibility relying on different systems within the PFC. Verdejo-Garcia et al. (2006) have observed poorer performance on cognitive tests of response inhibition and mental flexibility in polysubstance users than in control subjects. Neuroimaging study (Del Parigi et al. 2002) showed that brain responses to hunger/satiation in the hypothalamus, limbic-paralimbic areas (commonly associated with emotion regulation), and PFC (thought to involved in the inhibition of inappropriate response tendencies) are different in obese and non-obese individuals. Interestingly, Del Parigi et al. (2002) observed a larger decrease of activity in obese patients compared with non-obese individuals in the PFC and the orbitofrontal area for visual cues related to food. Karhunen et al (2000) suggested that left hemisphere and its frontal and prefrontal regions could play a role in the bingeing behaviour in obese individuals.

Braet et al. (2007) have found significantly more impulsive behaviour and lack of cognitive control in children with obesity supporting the idea of executive function deficit in obesity. Rising levels of obesity are a cause for concern because obesity is associated not only with adverse health outcomes but also with cognitive problems.

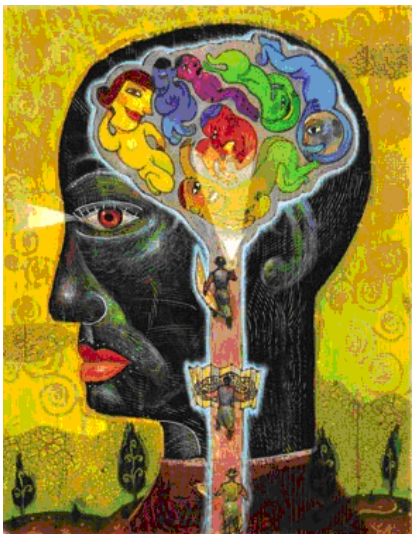
- *Anorexia nervosa*: The prefrontal cortex-based neuropsychological deficits found in AN patients appear to mirror their behaviours and personality characteristics (Tchanturia et al., 2004). Anorexia is characterised by high level of perfectionism, various degree of rigidity and behavioural constraint like limited eating behaviour (Vitousek et al., 1998). People with anorexia seem to be unable to face internal and external stimuli normally and easily and to adapt to changes in lifestyle and to deal with novelty (Brambilla, 2001). The component of this categorisation of personality includes *rigidity, lack of flexibility* and preoccupation for details (Strober, 1980). For example, participants with AN perform poorer on a series of cognitive tasks measuring *set-shifting* capacity, one of the sub mechanism of the executive function. Several studies have reported (Steinglass et al., 2006; Fassino et al. 2002)

impaired cognitive flexibility among women with anorexia nervosa, compared to healthy controls. Two studies using the Wisconsin Card Sorting Test (Tchanturia et al. 2001, Fassino et al. 2002) to investigate the prefrontal lobe function showed difficulty in developing new rules in AN. In the study of Tchanturia et al. (2004) perseveration was found in the AN group, as measured by the errors on both the Cognitive Set Shifting Task and the Picture Set Making Task. However, despite underweight and starvation state of the patients, the AN group did not show difference in performance on abstract problem solving (Palazidou et al. 1990).

Contrary to the findings of the previous study, Szmukler et al. (1992) reported impairment on the tests of visuospatial construction, as well as planning and problem-solving in AN patients. It seems also that deficit on the visuospatial construction have an influence on the body shape perception in AN. The findings of Thompson and Spana (1991) revealed a correlation between visuospatial deficit and the decrease in the accurateness of body shape estimation in normal individuals. It was suggested that in AN not the perception of the body shape is impaired but rather the interpretation and the explicit judgement of the body shape is different in comparison to control with normal body weight.

Williamson et al. (1990) reported that AN patients have a characteristic of *over-concern* with body shape and their weight resulting cognitive biases on the attention, the memory and the judgement of the body image.

3. Emotional functioning



The adolescent and adult eating disorder patients are characterised by deficits in emotional functioning (Zonnevijlle-Bendek et al. 2002). The eating disorders from the perspective of affect regulation are associated with affective disorders present in emotional functioning like inhibition of emotions (McCarthy, 1990). Words like 'just go on a diet' are as emotionally devastating to a person suffering from excessive overeating as 'just eat' can be to a person suffering from Anorexia" (Gordon, 1990). Many studies reported the frequent association with depression and anxiety with eating disorders (Bruch, 1982; Swift et al., 1986; Eizaguirre et al., 2004). *Alexithymia,* which literally means “no words for emotions”, it is a set of cognitive-emotional deficits. Alexithymia refers to a specific disturbance in emotional processing, which is marked by a difficulty identifying and expressing feelings and an externally oriented thinking style (Nemiah et al. 1976; Taylor et al. 1994). This emotional functioning deficit is characterised also by impoverished fantasy life, preference for concrete concerns, and avoidance in coping with conflicts or responding emotions (Pinaquy et al. 2003). Culhain and Watson (2004) suggested that alexithymia predicts emotional disturbance and difficulties in identifying emotions had uniquely negative mental health implications. Bruch (1962) considered the difficulty to distinguish and describe feelings as a main deficit in eating disorders related to a sense of general inadequacy and lack of control over one’s life.

Numerous studies revealed the existence of a relationship between alexithymia, depression and anxiety (Haviland et al., 1988; Hendryx et al., 1991; Eizaguirre et al., 2004; Montebarocci et al., 2006). Haviland et al. (1988) found a relationship between the recognizing and identifying feelings, and difficulty in communicating feelings dimensions of the Toronto Alexithymia Scale (TAS20), and depression. It has been shown that external oriented thinking, which is another dimension of alexithymia, is not related to depression. Hendryx et al. (1991)

suggested that alexithymia had a multidimensional feature and it could be an attempt to blockade negative emotions associated with stress in the normal population. In the study of Eizaguirre et al. (2004) patients with eating disorders (anorexia nervosa and bulimia nervosa) presented higher rates of alexithymia than in the controls, but after controlling for anxiety and depression the differences among groups disappeared. Depression and anxiety predicted and correlated positively with alexithymia. Eizaguirre et al. (2004) proposed that alexithymia and eating disorders both strongly relate to depression and anxiety, and alexithymia is a personality trait in some specific patients with eating disorders, whereas in most of the cases alexithymia is a secondary state due to depression and anxiety.

- *Obesity:* Significantly higher prevalence of depression in obese adults has been descried by the study of Palinkas et al., (1996) and in obese children by Csabi et al. (2000). Dixon et al. (2003) examined the severity of depression in obesity measured by Beck Depression Inventory (BDI) before and at yearly intervals after gastric-restrictive weight-loss surgery. Their results showed that higher scores, indicating increased symptoms of depression, were found in younger subjects, women, and those with poorer body image. Weight loss was associated with a significant and sustained decrease of depression scores. Greater decrease in BDI score at 1 year were seen in women, younger subjects, and those with greater excess weight loss. It suggest that depression in obesiy is associated with the level of body dissatisfaction.

  It was proposed that anxiety and depression both are associated with obesity (Kaplan & Kaplan, 1957; Ruderman, 1983; Kaplan et al. 1994; Callahan, 1991) Kaplan & Kaplan (1957) proposed that the eating serves to reduce anxiety (such as alcohol helps to reduce anxiety to the patients with substance abuse). Food addictions caused by anxiety, and all addictive substances, including food, are tranquilizers that serve to mask anxiety (Kaplan et al. 1994). “The reason most diets don't work is because they treat the symptom (eating) rather than the cause anxiety” (Callahan, 1991). In contrary to the anxiety reduction hypothesis in obesity, Ruderman (1983) have found that obese individuals ate significantly less when they are highly anxious than when they feel only mildly anxious. His findings showed that obese people consume the maximum quantitiy of food when they are at moderate level of anxiety. Later eating was regarded as a

copying behaviour to make the individuals feel better and to avoid feeling and expressing negative emotions (Bekker and Boselie, 2002). Significantly higher alexithymia was reported also in binge-eater obese female in the study of Pinaquy et al. (2003). The findings indicated that obese women who have difficulty identifying and communicating their feelings have a tendency to eat in response to emotions. However, the relationships between alexithymia, emotional functioing and eating behavior in obesity have been sparsely studied and poorly understood.

- *Anorexia nervosa*: Emotional functioning deficit in anorexia nervosa is characterised also by avoidance in coping with conflicts or responding emotions (Pinaquy et al. 2003). Kucharska-Pietura et al. (2004) have found that women with anorexia nervosa had difficulties to recognise emotion in faces, which was most marked for negative emotions. It was reported that anorexic patients have a tendency to avoid negative emotions, and to inhibit negative emotion expression, especially they are prone to suppress anger (Bruch, 1962, Geller et al., 2000).

  Blinder et al. (2006) observed that patients with anorexia nervosa reported mood disorders (94% of the cases unipolar depression) and anxiety disorders (56 % of the cases). Godart et al. (2006) showed that generalized anxiety is the most frequent disorder in AN and it appears to be one of the main predictive factor for major depressive episode. Kaye et al. (2004) suggest that anxiety disorder appears in childhood and it presents before the onset of the anorexia nervosa. This supports the possibility of anxiety being a vulnerability factor for developing anorexia nervosa. Using the Toronto Alexithymia Scale (TAS20) higher prevalence of alexithymia was found in the anorexic population than among substance abusers, in chronic diseases or general psychiatric out-patient (Bourke et al., 1992). Based on this result we suppose that alexithymia is associated with the pathology of anorexia nervosa. Montebarocci et al. (2006) showed that although patients with anorexia reported higher alexithymia compared to control it was mainly related to negative affect, the significant group differences had disappeared when alexithymia was controlled for anxiety and depression.

4. Attitudes

Rucker & Cash (1992) maintained that body image includes at least two components: perceptual body image (i.e., estimation of one's body size) and attitudinal body image (i.e., affective, cognitive, and behavioural concerns with one's body size). Individuals with eating disorders overestimate or distort the size of their body more and they are more dissatisfied and preoccupied with their appearance, and tend to avoid more social interactions because of their appearance than normal weight individuals (Gardner et al. 1987). Allport (1935) defined attitudes as a "mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related". Attitudes are privates, formed and organized through experiences. They are acquired via socialization process and as it are believed to directly influence the behaviour. Attitude is comprises three parts (Allport, 1935): the *affective* component is the emotional one and it is a response that expresses an individual's preference for an entity (like or dislike an object). The *behavioural* component is the overt or visible behaviour attached to the internal attitudes and the *cognitive* component is where information is stored and organized about an attitude object. The affective component makes attitudes different from a purely cognitive categorization. *Explicit attitudes* are usually equated with deliberative, self-reported evaluations and come from conscious judgements. Traditionally, affective responses toward body image and food have been assessed by direct explicit measures like questionnaires or interviews both in obesity and anorexia nervosa. However, there is a high possible risk of obtaining data "contaminated" with the desire to suit to social expectation or self-presentation biases. *Implicit attitudes* are preferences that exist outside of conscious awareness or conscious control. A prominent conception is that implicit attitudes stem from past (and largely forgotten) experiences, whereas explicit attitudes reflect more recent or accessible events (Greenwald & Banaji, 1995). Therefore, implicit attitudes are more stable, changes along the time happen less likely in the implicit attitudes than in the explicit ones. Gawronski et al. (2007) proposed that implicit and explicit evaluations

differ on the grounds that implicit evaluations are the outcomes of the activation of associations mostly from memory, which can be either conscious or unconscious. While explicit evaluations reflect the result of a conscious validation process, which would represent the judgement of the person about the object. Explicit attitudes can be assessed by using classical methods such as interviews or questionnaires. Implicit attitudes can be assessed through reaction time tasks, which yield evaluations that are unlikely to be controlled, and those measure people's attitudes or beliefs indirectly (i.e. without asking them how do they feel or think). These tasks based on the idea that subject's attention is focused not on the attitude object, but on performing an objective task. The association between negative/positive values and attitude object influence the time reaction of the subject that can be measured from the systematic variation on task performance (Rudman, 2004).

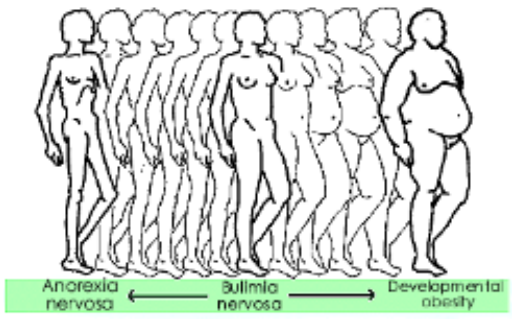
The use of emotional Stroop task in eating disorder to measure information processing is very common (Lee & Shafran, 2004). Stroop task is a colour naming task and the Stroop effect is a demonstration of interference in the reaction time of a task (Cooper et al. 1992). In the emotional Stroop task the same effect is used for naming emotionally charged stimuli, like words linked to body image or food in eating disorders. It was reported that patients with eating disorders differ from healthy controls in a way that the speed of processing food or body related words is longer. It suggests that patients with eating disorders are over-concerned and treat the information related to food or body image differently from the individuals with normal body weight. Recent cognitive accounts of emotional disorders have suggested also that biased information processing may act as an important role in the eating disorders (Lee & Shafran, 2004). Information processing deficit in eating disorders touches mostly the environmental triggers related to *food, body image, and self* (Vitousek & Hollon, 1990). These biases include selective attention and perception to maintain body size overestimation and attention to body sensation and affects, which are misinterpreted as evidence of fatness (Fairburn et al. 1990).

- *Obesity:* The information processing and the implicit attitudes towards body shape in obesity have not yet been studied and poorly understood. In the study of Roefs & Jansen (2002) using the most classical implicit task the Implicit Association Task (IAT) automatic pro-fat contained food bias is indicated with the faster response latency during categorisation. Surprisingly, they found rather

negative implicit attitude toward high fat contained food in obesity when it was compared to normal weight control subjects. However, it was reported that children and adolescents with obesity had a more pronounced positive implicit attitude towards food in general (Craeynest et al., 2005). Studies concerning the comparison of the implicit and explicit attitudes towards thinness or fatness in obesity have not been published yet.

- *Anorexia nervosa:* Anorexia nervosa patients were not showing a relative preference for palatable foods in the same IAT study (Roefs et al., 2005). Considering body image just a few studies were done on the implicit and explicit measures. Vartanian et al. (2005) suggest that restrained (anorexic) and unrestrained eaters both had strong implicit negative attitudes toward fatness, but restrained eaters had stronger negative explicit attitudes and beliefs about fatness. IAT was used also in the study of Schwartz et al. (2006) to assess attitudes towards participants' own bodies in healthy individuals. They found that healthy thin people were more likely to automatically associate negative attributes with fatness.

5. Common dimensions in the eating disorders



The several common dimensions and overlapping in the psychopathology and diagnostic criteria of theeating disorders (anorexia nervosa, bulimia nervosaand obesity) suggested the possibility of a continuum model (Vandereycken 1982). Based on this continuum model the eating disorders could be described on a continuous spectrum. Vandereycken (1982) proposed the idea of the dysorexi-dysponderosis dimensions integrated in one dynamic model, considering other variables like the time, the spontaneous life events and the iatrogenic factors. Using the model of Vandereycken the following sub-groups could be identified in the eating disorders (see figure 3): restrictive anorexic,

purging anorexic, bulimic, thin-fat people (obese people with anorexic traits), and stable obese groups.

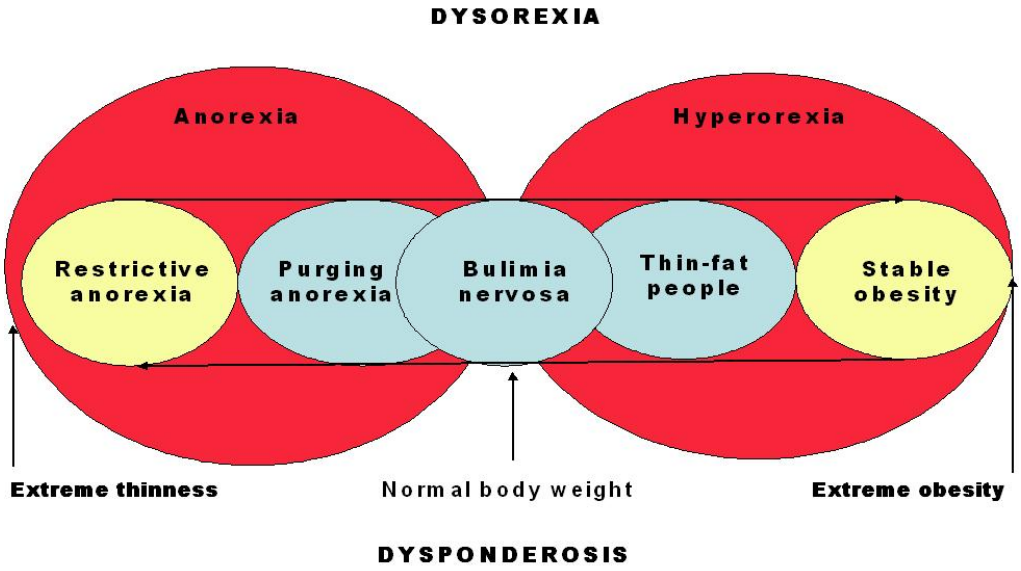


Figure 3. Continuum model of eating disorders after Vandereycken, 1982

In the Table 2 we summerized psychological, behavioural, demographic- social and physical characteristics of the the eating disorders' sub-groups (Goldbloom & Kennedy, 2005). The Table 2 provides an overview of the similarites and the differences in the pathologies of the eating disorders. Research in this area has been revealing, suggesting that for certain behavioral and psychological factors, such as maladaptive eating behaviors (Dancyger and Garfinkel, 1995), concerns about body shape and thinness (Mintz & Betz, 1988; Thompson, et al., 1987), interoceptive awareness (Tylka & Subich, 1999) and dysfunctional cognitions concerning food and weight (Thompson et al., 1987; Tylka & Subich, 1999), healthy eaters are commonly differing from those with eating disorders. Eating disorders are considered to lie on a spectrum of disorders with varying degrees of dimensions. Restrictive anorexia nervosa patients (AN-R) are thought to belong to the obsessive pole of the spectrum, and purging-anorexia (AN-P) and bulimia nervosa (BN) patients to the impulsive pole (Bellodi et al. 2001). The model suggests that eating disorders situated on the two extreme sides of the model (e.g. restriction and obesity) should represent the two poles of the same psychological or behavioural spectrums.

Table 2 Summary of the psychological, behavioural, social and physical characteristics of the eating disorders.

	Anorexia *restrictive*	**Anorexia** *purging type*	**Bulimia**	**Obesity**
Psychological				
Body image problem	High	High	High	Increased
Fat phobia	High	High	Normal	No
Rigidity, lack of flexibility	High	High	Increased	Increased
Body, weight concern	High	High	High	High
Self esteem	Low	Low	Low	Low
Control	High need of control	High need of control	Lack of control	Loss of control
Alexithymia/poor insight	High	High	High	Sometimes
Depression	High	High	High	High
Anxiety	High	High	High	High
Perfectionism	High	High	Normal	Normal
Obsessive/compulsive	High	High	Normal	Normal
Impulsivity	Low	Normal	High	High
Behavioural				
Eating	Restriction, bizarre habits	Sometimes bingeing	Bingeing several times a day	Bingeing, overeating
Dieting	Yes	Yes	Yes	Sometimes
Bingeing	No	Sometimes	Frequent	Frequent
Exercising	Frequent	Frequent	Sometimes	No
Self induced vomiting	No	Sometimes	Frequent	No
Misuse of laxatives	No	Sometimes	Frequent	No
Secretive about eating	Often	Often	Sometimes	Sometimes
Possible self-harm, substance abuse or suicide attempts	Suicide attempts, self harms	Substance abuses, suicide	Substance abuse, impulsive acts	Abuses
Demographic and Social				
Social status	High	High	Normal	Low
Onset age	10-12	11-14	14-16	Anytime
Relationship with the family	Dependent	Less strong	Ambiguous	Protective
Social isolation	Withdrawal	Withdrawal	No	No
Stigmatization	No	No	Sometimes	Often
Physical				
Body weight	Low <17	Low <17	Normal >17	High >27
Diabetes II	No	No	Possible	Often
Menstrual disorders	Often	Often	Rarely	Often
Blood pressure	Hypotension	Hypotension	Normal	Hypertension
Sleeping disorders	No	No	No	Often
Cardiovascular problems	Poor circulation, bradycardia	Poor circulation, bradycardia	Tachycardia, heart failure	Congestive heart failure, enlarged heart
Endocrine problems	Reduced metabolism, lack of zinc	Gastrointestinal, low potassium	Gastrointestinal problem, low potassium	High cholesterol
Articulation, bones	Creaking joints, bones	Creaking joints, bones	Destroyed teeth	Osteoarthritis

Part II Hypotheses

6. To eat or not to eat, two sides of the same coin?

6.1. Excessive eating (obesity)

1. Rising levels of both childhood and adult obesity are a cause for concern because obesity is associated not only with adverse health outcomes but also with cognitive problems. However, the cognitive deficits have not been investigated and the possibilities are not well defined. Therefore, it is hypothesised, that, like substance users, obese patients will show deficits specifically in tasks associated with functions of the PFC.

- **1.1**. First, we compared cognitive profile of obese but otherwise healthy children to children with a normal weight on five different neuropsychological tasks evaluating PFC based executive function, intelligence, memory and attention. We expected to find significant group differences only on the PFC based mental flexibility. It would suggest that the possible existence of *executive dysfunction in childhood obesity* couldn't be explained by other type of cognitive deficits like memory problem or intelligence.
- **1.2**. Secondly, we compared cognitive profile of obese but otherwise healthy individuals to adults with normal body weight on neuropsychological tasks assessing PFC based mental flexibility, memory, and attention. We presume to find similar cognitive deficit on the *PFC based executive function in adult obese patients* than in obese children. The existence of the executive function deficits both in childhood and adult obesity would confirm the hypothesis about the addictive nature of obesity.

2. Most probably due to the thin body ideal of the modern society and the increasing social pressure considering the importance of the physical appearance, depression has been found as co-morbidity factor in obesity (Friedman et al., 2002;

Annunziato & Lowe, 2007). Using self reported questionnaires significantly higher depression was found in obese adults (Palinkas et al., 1996, Dixon et al., 2003). However the relationship between depression and anxiety in obesity is still unclear

- **2.1.** First, we will measure the level of depression, anxiety and negative affectivity using self reported questionnaires in the obese and the control groups. We expect to find significantly *more negative affectivity, anxiety and depression in the obese* group.
- **2.2**. Second finding of Dixon et al (2003) showed that severity of obesity and the poor body image were related to the level of depression. Based on the findings of Dixon et al., we predict to find positive relationship between *negative affectivity, depression, anxiety and the severity of the obesity* (BMI).
- **2.3.** Third, women are exposed daily to sociocultural messages about how they should look (e.g., be thin, be physically fit). We presume that these sociocultural pressures increase obese women of being not only in negative mood and anxious but also to have higher psychological stress. We measured the level of distress in obese and control groups using computed indexes of the Symptom Check List 90-R.

3. Until now a few studies were carried out on the relationship between executive function deficits and mood in eating disorders (depression, Wilsdon & Wade, 2006; Tchanturia et al., 2004). Weiland Fiedler et al (2004) suggested that deficit in sustained attention is a specific marker in depression. Holmes and Pizzagalli (2007) showed that subclinical depression is associated with impairment on executive functions. Therefore, we expected that the possible *deficits on the executive functioning in obesity would be related to the negative affectivity* pre-occupation (anxiety) and/or *negative mood* (depression).

4. The patients with eating disorders are characterised by deficits in emotional functioning (Zonnevijlle-Bendek et al. 2002). Significantly higher alexithymia was reported also in binge-eater obese female in the study of Pinaquy et al. (2003). However, the relationship between obesity, *alexithymia in the context of depression and* anxiety has not yet been fully investigated.

- **4.1**. We will assess the presence of alexithymia in the obese adult group compared to healthy controls. We presume to find *more alexithymia* assessed by the 20-item Toronto Alexithymia Scale in the obese group than in the control group.
- **4.2.** Following the finding of the previous studies (Eizaguirre et al. 2004; Montebarocci et al 2006) we will investigate the role of depression and anxiety in the alexithymia. We expect to find no significant group difference on *alexithymia in obesity and control group when alexithymia scores will be controlled for depression and anxiety.*

5. Hendryx et al. (1991) suggested that alexithymia had a multidimensional feature and one could be an attempt to blockade negative emotions. Vermeulen et al. (2006) suggested that alexithymia has a moderating affect on the treatment of the emotional stimuli at an implicit level. Based on the findings, we will investigate the treatment of facial emotion stimuli on the implicit level in obesity. We will use the affective priming task in order to *compare implicit treatment of different emotions* (sad, angry, and happy) represented on a schematic face.

- **5.1.** Based on the findings of previous studies showing the relationship between the alexithymia and the blockade of the negative emotions we expect to find difference in the treatment of negative and positive emotions between control and obese groups. Based on the relationship between obesity and depression we assume that *obese patients would treat the negative emotions* specially sadness *faster* than control group because sadness seems to be congruent with their own mood.
- **5.2**. Base on our previous assumption concerning the relationship between Psychological distress (assessed by the GSI index of the Symptom Check List 90) and obesity, because obesity adds additional stress to the normal range of daily negative emotions. Therefore we expect that the psychological distress has an positive influence on the treatment of the negative emotional information both sadness and anger.
- **5.3.** It has been shown that alexithymia has also a moderating effect on emotional information processing on the implicit level, which cannot be explained by mood or negative affectivity (Vermeulen et al., 2006). We

assume that alexithymia has moderating effect on the emotional information processing on both positive and negative emotions independently from the groups.

6. Rucker & Cash (1992) maintained that body image includes at least two components: *perceptual body image* (i.e., estimation of one's body size) and *attitudinal body image* (i.e., affective, cognitive, and behavioural concerns with one's body size). Obese individuals are overestimate or distort the size of their body more and they are more dissatisfied and preoccupied with their appearance (Gardner et al. 1987; Sorbara & Geliebter 2002 Wardle & Rapoport 2001). *Explicit* attitudes are self-reported evaluations, while *implicit* attitudes are preferences that exist outside of the conscious awareness stem from emotional processes. Explicit and implicit attitudes seem to affect people's behaviour, though in different ways.

- **6.1**. We will measure the perceived actual body shape of obese and control subjects on a Body Figure Scale. Based on the finding of Gardner et al. (1978) we supposed that *obese patients would overestimate their own body* weights on the scale.
- **6.2**. We will measure the ideal body shape on the Body Figure Scale (body figure that the participants would consider as ideal) in obesity. We presume that *obese women would consider more feminine type of body shape (with higher BMI) as ideal than control.*
- **6.3**. It was reported also higher level of depression and anxiety in obesity in relation with body dissatisfaction. We investigate the relationship between explicit (assessed by Eating Disorder Inventory) body dissatisfaction, perceived and ideal body shape and negative affectivity in obesity. We assume to *find positive correlation between depression and body dissatisfaction in obesity. Furthermore we expect that the negative affectivity and body dissatisfaction would correlate positively with the distance between ideal and perceived body shape in obesity.*
- **6.4**. Body image includes the attitudinal component, which can be explicit (self-reported) or implicit (out of direct self awareness). We will assess both explicit and implicit attitudes toward different body shapes (underweight, normal, overweight, obese) in obesity. We expect to find *differences between*

explicit and implicit attitudes towards body shape in obesity when they are compared to healthy normal weighted controls. Our hypothesis is that generally the diets don't work in obesity or obese female regain their weight, because implicitly obese females do not have fat phobia, they do not dislike obese body figure as females with normal body would do. Therefore we suppose that *obese patients would show more positive implicit attitudes towards obese figures* than controls by performing on the implicit tasks.

6.2. Restrictive eating (restrictive anorexia nervosa)

7. The results of several studies revealed that AN patients perform poorer on a series of cognitive tasks measuring executive functioning. However, there is no consensus in the question which of the sub mechanism of the executive function would be problematic in AN. Therefore, we compare cognitive profile of female patients with anorexia nervosa only restrictive type to healthy control females on different neuropsychological tasks evaluating PFC based executive function, intelligence, memory and attention. We suppose to find significant *group differences only on the PFC based mental flexibility*. It would suggest that the possible existence of executive dysfunction in AN restriction which can not be explained with other type of cognitive deficits.

8. It has been demonstrated that anorexia nervosa patients evidence comorbidity with mood disorders such as unipolar depression and anxiety disorders (Blinder et al., 2006). Negative mood (depression), anxiety and certain personality factors associated with anorexia nervosa (i.e. perfectionism) are variables which might mediate cognitive performances. An increasing number of studies show that subclinical depression contributes to executive function deficits (Holmes and Pizzagalli, 2006). However, Wilsdon & Wade (2006) observed executive function deficits in AN independently from depression. We will examine the role of depression, anxiety and specific personality factors (perfectionism, ineffectiveness) in cognitive functioning. We supposed that *negative mood and anxiety would influence*

negatively the performance on the cognitive tasks, while perfectionism would be linked to better performance.

9. Emotional functioning deficit are also present in anorexic nervosa (Zonnevijlle-Bendek et al. 2002). Using Toronto Alexithymia Scale (TAS20) higher prevalence of alexithymia was found in the anorexic population than among substance abusers, in chronic diseases or general psychiatric out-patient (Bourke et al.,1992).

- **9.1.** We will assess the presence of alexithymia in the anorexic group compared to healthy controls. We presume to find more alexithymia assessed by the 20-item Toronto Alexithymia Scale in the anorexic group than in the control group.
- **9.2.** Following the finding of the previous studies (Eizaguirre et al. 2004; Montebarocci et al 2006) we will investigate the role of depression and anxiety in alexithymia. We supposed that alexithymia in anorexia nervosa would be related to more the negative mood states (depression).

10. Similarly to, the previous hypothesis 5, we will investigate the treatment of facial emotion stimuli on the implicit level in anorexia nervosa. We will use the affective priming task in order to compare implicit treatment of different emotions (sad, angry, and happy) represented on a schematic face.

- **10.1.** Clinical reports observed that anorexic patients have a tendency to avoid negative emotions, and strong emotional situation (Bruch, 1962). Based on this observation and the presence of the depression in anorexia we assume that anorexic patients will treat the negative emotions faster differently from the control group.
- **10.2.** We expect that the psychological distress has a positive influence on the treatment of the negative emotional information both sadness and anger. Psychological distress (assessed by the GSI index of the Symptom Check List 90) would relate to the treatment of the emotional information.
- **10.3**. It has been shown that alexithymia has a moderating effect on emotional information processing on the implicit level in healthy participants. But until

now no research was made on the relationship between alexithymia and the implicit treatment of emotional information in anorexia nervosa. We supposed to find different emotional information processing on both positive and negative emotions in anorexia and alexithymia will have a moderating effect on these processes independently form the groups.

11. Negative assumption of body image and body dissatisfaction is an important factor in the pathology of anorexia nervosa (Cooper and Turner, 2000). It was demonstrated that patients with anorexia nervosa have more negative explicit attitudes towards fatness than healthy controls. *However, explicit* attitudes are self-reported evaluations, while *implicit* attitudes are preferences that stem from emotional processes. As explicit and implicit attitudes can affect people's behaviour in different ways, therefore we are interested in this point how explicit and implicit evaluation of different body shapes are relate to each other in anorexia nervosa.

- **11.1**. First, we investigate the relationship between explicit (assessed by Eating Disorder Inventory) body dissatisfaction and negative affectivity in anorexia. Because higher level of depression and anxiety is associated with anorexia nervosa therefore we assume to *find positive correlation between depression, anxiety and body dissatisfaction in anorexia.*
- **11.2**. We will measure the explicit evaluation of different body figures on a 7-point scale in the anorexic group and in the control group. Clinical observation revealed that females with anorexia nervosa are obsessed by a strong desire to loose weigh and look like a model with slim body. We presume that anorexic patients would judge more positively the underweight slim body and more negative the overweight body than control group.
- **11.3**. Body image includes the attitudinal component, which can be explicit (self-reported) or implicit (out of direct self awareness). We will assess implicit attitudes toward different body shapes (underweight, normal, overweight) in anorexia. We expect to find *more positive implicit attitudes towards underweight body shape in anorexia nervosa* than in healthy controls with normal body weight.
- **11.4.** As depression and anxiety is associated with anorexia nervosa, we examine whether negative affectivity is influence the evaluation of the body

shapes either explicitly or implicitly. We investigate also whether other personality factors such as perfectionism (e.g. one of the main personality dimension in anorexia nervosa) or drive for thinness how explicitly or implicitly would influence the body shape evaluation.

6.3. Can excessive eating and restrictive eating be the two sides of the same coins?

12. The main goal of this thesis is to examine the existence of certain *common dysfunction related to* the two extreme sides of the continuum model (restrictive anorexia and stable obesity). The similar deficits associated both with obesity and restrictive anorexia nervosa would confirm the continuum hypothesis in the development of eating disorders. If the continuum model is valid than we should find similar problematic functioning and impairment both in obesity and anorexia nervosa in the following functioning:

- **12.1**. PFC based executive function mirroring rigid behaviours and lack of flexibility. Therefore we expect to measure the same dysfunction in obesity than in anorexia nervosa.
- **12.2**. Treatment of the emotional information linked to the negative emotions would be similarly disturbed in obesity and anorexia nervosa. We presume that patients groups will be more sensitive to negative emotions than control groups because of the depressive statues commonly present in both obesity and anorexia.
- **12.3.** Different attitudes towards body image both in obesity and anorexia compared to control subjects. We suppose that both patients group will evaluate implicitly body shapes similar to their own body weights more positively than control groups (obese group is more positive toward obese figure vs. anorexic group is more positive toward underweight figure).

Part III Materials

7. Neuropsychological tasks

The neuropsychological tasks are used to measure different cognitive abilities (i.e.: short/long term memory, working memory, different types of the attention, execution, decision making, planning, shifting, problem solving, and visuospatial capacities) and to investigate possible cognitive deficits, which are related to specific brain structures. The advantage of the neuropsychological tasks in comparison with questionnaires is that they are less culture dependent and can assess subjects from early age.

7. 1. Raven's Progressive Matrices (Raven et al, 1992)

Raven's Progressive Matrices (Raven test) are widely used non-verbal intelligent tests. It was designed to assess the ability of forming perceptual relations discursively on visual stimuli, to measure logical reasoning, and making sense of complexity independently of language, culture and formal schooling. In each test item, the participants are asked to find the missing part required to complete a given pattern. It consists of five set of items (i.e. A, B, C, D, E) and each set gets progressively harder, requiring greater cognitive capacity and involvement to encode and find the right answer (see example Set A, number 1 in the Appendix 7). The Progressive Matrices are offered for participants having age range from six years to adulthood and it should be completed in maximum 40 minutes. The score of the subjects corresponds to the total number of correct responses, which allows us to derivate an approximate Intelligence Quotient (I.Q.).

7. 2. Digit span memory test (Wechsler, 1997)

The digit span memory task (DS) is a verbal measure of immediate memory and working memory maintenance and manipulation (subtest of the WAIS-III,

Wechsler 1997*).* The subjects are asked to repeat a number of digits after having been presented orally by the examiner. The list length began with two digits and increased sequentially until recall errors were made on at least one of the two trials. The increasing set of numbers' backward recall can assess working memory performance. Performances of participants were calculated from the numbers of digits they could repeat without mistakes.

7. 3. D2 attention endurance test (Brickenkamp, 1981*)*

The D2 attention endurance test (D2 test) was chosen to measure attention endurance and visual scanning (see Appendix 6). This clinical test is used to assess concentration ability and attention distractibility both in children and in the adult population. D2 is a paper-and-pencil task requiring the participants to identify targets (D letter with two apostrophe marks that can be located either both on the top of the D letter or below the or one mark on the top other one is below) by crossing them out with a pen. Participants should also ignore distracters (i.e. P letter or D with one or three marks). The stimuli are arranged in 14 lines containing 47 letters each. Each line should be scanned in 20 seconds, when the 20 sec is up examiner asks the subject to move to the next line. Scores are calculated based on the speed (number of symbol scanned) or accuracy (number of error) of the participants. Two types of errors could be committed: either target symbols are omitted or the distracter symbol is crossed out.

7. 4. Hayling Sentence Completion task (Burgess & Shallice, 1997)

The Hayling test is a neuropsychological test of executive function created by psychologists Burgess and Shallice in 1997. The Hayling test is a measure of response initiation and response suppression. It consists of two sets (Hayling A and B) of 15 sentences each having the last word missing. In the first part (Hayling A) the examiner reads each sentence aloud and the participant has to simply complete the sentences, yielding a simple measure of response initiation speed. The second part of the Hayling (Hayling B) requires subjects to complete a sentence with a nonsense ending word (suppress the "sensible word" that would make sense of the presented

sentence), giving measures of response suppression ability and thinking time. This test is entirely spoken and is thus suitable for people with a wide range of problems such as those involving reading, visual perception or movement. The test takes approximately five minutes to administer. It measures the executive functioning through the speed (time to complete A or B part of the task) or accuracy (number of the errors) of the subjects. The score of the speed and error of Hayling B assess the suppression ability, while the mental flexibility is evaluated by the difference between the A and the B parts.

7. 5. Trail making task (Reitan, 1956, 1958)

The Trail making test (TMT) is primarily a test of motor speed and visual attention exploring visual-conceptual and visual-motor tracking (see Appendix 9). It is a frequently used neuropsychological test because of its ease of administration and sensitivity to brain damage. It consists of two parts: the TMT A and the TMT B. In Part A, the participant is asked to quickly draw lines on a page connecting 25 consecutive numbers. In Part B, it requires participants to draw the line connecting a series of circles by alternating between consequently numbered and lettered circles (i.e. 1-A-2-B-3-C, see Appendix 10). Performance on test A requires, at a basic level attention, concentration, and visuomotor tracking (involves motor speed and attention function). The B requirements include perceptuomotor speed, mental flexibility (a dimension of the executive function) and several other aspects of executive function such as planning, organizing, and executing (Gaudino et al. 1995). The difference between B and A (TMTB-A) speed (time of completion) provides a more clear measure of the mental flexibility because of TMT A would serve as a motor speed baseline of each participant. Thus, poor performance on completion time and performance errors of the part B and the B-A may reflect difficulties in a number of dimensions of the executive function (Waldstein et al. 1998).

7. 6. Semantic - Phonetic Verbal fluency (Milner 1964, Benton 1968)

The Semantic - Phonetic Verbal fluency test is a sensitive neuropsychological test, used to detect spontaneous verbal flexibility and inhibition. Milner (1964) and

Benton (1968) first introduced the verbal fluency test in order to be able to evaluate the overall productivity of brain-damaged patients. The ability to generate verbal responses according to several rules (i.e., semantic or phonemic categories) is linked to the PFC function (Troyer et al., 1998). The semantic verbal fluency test requires first an exploration of conceptual knowledge, and than the search strategy according to semantic category. In the semantic verbal fluency test the participants were asked to produce as many words as they could during one minute, all words belonging to one of the given categories such as animal; fruit; dress & profession (alternating them). In the phonetic verbal fluency test participants had to list up as many word as they could during one minute based on phonetic rules (starting with letter P, or alternating between P and S as a first letter). The test score was the number of correct words pronounced during one minute.

7. 7. Wisconsin Card Sorting Test (Berg, 1948)

The Wisconsin Card Sorting Test (WCST) is used to measure cognitive flexibility and shifting ability (see Appendix 8). This test was administered to assess the children's capacity for recognizing a rule, maintaining it and changing it when it is not valid any more. Participants were required to sort different cards on the basis of perceptual attributes (colour, form, and number). The only feedback provided by the examiner was whether responses were correct or incorrect. The sorting rule was changed after 6 consecutive correct responses given by the participant. Having completed each sorting rule twice or reached the maximum 128 trials, the testing finished. WCST is a good clinical tool for detecting frontal lobe dysfunction such as perseveration and lack of inhibition. In particular, patients with lesions of the dorsolateral frontal lobe make a higher number of perseverative errors than control participants (Milner, 1963). Having achieved the first category they often continue to sort the cards according to the first rule long after that rule has been superseded. A recent factor analysis of the WCST has shown these perseverative errors to be the most useful outcome measure in deficits of "executive dysfunction" (Greve et al., 2005).

8. Explicit measures

8. 1. Questionnaires

8. 1. 1. Eating Disorder Inventory (Garner et al. 1983)

Eating Disorder Inventory (EDI) is a 64 item self-reported inventory and designed to provide information on eight separate dimensions of cognitive and behavioural aspects of anorexia nervosa and bulimia. The EDI assesses attitudes, feelings and behaviours related to food, eating and body image. The eight subscales that comprise the EDI are called: Drive for Thinness (DT; “I am terrified of gaining weight”), Bulimia (B; “I stuff myself with food”), Body Dissatisfaction (BD “I think my hips are too big”), Ineffectiveness (I; “I feel inadequate”), Perfectionism (P; “I have extremely high goals”), Interpersonal Distrust (ID; “I need to keep people at a certain distance”), Interoceptive Awareness (IA; “I don't know what's going on inside me), and Maturity Fears (MF; “I wish that I could be younger”). Subjects are asked to respond to a 6-point forced-choice format by rating how much the item applied to them. Options ranged from `always' to `never'. The most extreme eating disorder response earns a score of 3, the intermediate response scores 2, and the next response scores 1; the other three responses receive no score.

8. 1. 2. 20-item Toronto Alexithymia Scale (Taylor et al. 1994)

The 20-item Toronto Alexithymia Scale (TAS-20) is a mostly used tool of measuring alexithymia construct (see Appendix 14). We used TAS-20 to evaluate emotional functioning through the importance of recognising and expressing emotions and distinguishing between bodily sensations of emotional arousal. The alexithymia scale has three subscales; 1, the difficulty identifying feelings (DIF; “I often don’t know why I am angry”); 2, difficulty describing feelings (DDF; “It is difficult for me to find the right words for my feelings”) and 3, externally oriented thinking (ET; “I prefer talking to people about their daily activities rather than their

feelings"). The TAS-20 consists of self-report statement of 20 items on 5 -point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). Possible score range from 20 to 100, above 60 score we consider alexithyimic personality trait. We have translated the 20-item Toronto Alexithymia Scale in Hungarian language and carried out also the validation of the translation and the factors structure of the TAS20 on the data of 275 undergraduate university students. Our results showed that the Hungarian TAS20 is an appropriate clinical tool to assess alexithymia in the Hungarian population. The description of the validation procedure and the discussion of the results are available in the article of Cserjési Renáta, Luminet Olivier and Lénárd László: RELIABILITY AND FACTOR VALIDITY OF THE HUNGARIAN TRANSLATION OF THE TORONTO ALEXITHYMIA SCALE IN UNDERGRADUATE STUDENT SAMPLES published in Pszichológiai Szemle 62/3. 2007.

8. 1. 3. Positive Affectivity Negative Affectivity Schedule (Watson et al. 1988)

Positive Affectivity Negative Affectivity Schedule (PANAS) is a self-rating measure of mood state (see Appendix 13). It consists of the 10 items for Positive Affectivity Schedule (PA) assessing positive (e.g. interested, proud) and 10 items for Negative Affectivity Schedule (NA) measuring negative (e.g. upset, anxious) emotional states. Participants indicated their degree of approval on 20 items on a 5-point scales ranging from 1 (not at all) to 5 (extremely). The PANAS schedule is the most wildly used scale for evaluation of current state. The scores on each schedule are from 10 to 50.

8. 1. 4. Beck Depression Inventory II (Beck, 1996)

Beck Depression Inventory II (BDI-II) is a revised version of the BDI-I and it is a 21 item self-report rating inventory measuring characteristic attitudes and symptoms of depression. The items are symptoms of sadness, pessimism, past failure, loss of pleasure, self-dislike self-criticism, and suicidal thoughts and wishes. A 21 item questionnaire with each item rated on a 4 point scale (from 0 "I do not feel sad"

to 3 “I am so sad or unhappy that I can’t stand it”.). The score is calculated 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.

8. 1. 5. State-Trait Anxiety Inventory (Spielberger, 1983)

The State-Trait Anxiety Inventory (STAI) is a self-rating measure of anxiety and it consists of two parts the State (describing the actual situation) and the Trait (general measure of anxiety) anxiety (see Appendix 12). Participants indicated their degree of approval on 20 items for each form of STAI (e.g. I am satisfied”, I have thoughts that disturb me”) on a 4 –point Likert scale ranging from 1 “No” to 4 “Yes”. Possible scores range from 20 to 80 for each form.

8. 1. 6. Symptom Check List 90 –R (Derogatis, 1977)

The Symptom Check List 90-Revised (SCL-90-R) is a new version of the “Symptom Check List 90”. It is a self-report instrument from Pearson Assessments and helps evaluate a broad range of psychological problems and symptoms of psychopathology. The instrument is also useful in measuring patient progress or treatment outcomes. Clinical psychologists, psychiatrists, and professionals in mental health, medical, and educational settings as well as for research purposes use the SCL-90-R instrument. It can be useful for the initial evaluation of patients at intake as an objective method for symptom assessment. It is adapted to measure patient progress during and after treatment to monitor change and clinical trials to help measure the changes in symptoms such as depression and anxiety. The SCL-90-R consists of 90 items assessing nine groups of symptoms. The nine subscales and an additional on that comprise the SCL-90-R are called: Somatization (SOM; “Numbness or tingling in part of the body”), Obsessive-Compulsive (O-C; “Having to check and double-check what you do”), Interpersonal Sensitivity (I-S “Feeling that people are unfriendly or dislike you”), Depression (DEP; “Feeling hopeless about the future”), Anxiety (ANX; “The feeling that something bad is going to happen to you”), Hostility (HOS; “Feeling easily annoyed or irritated”), Phobic Anxiety (PHOB;

“Feeling nervous when you are left alone”), Paranoid Ideation (PAR; “Feeling that most people cannot be trusted”), Psychoticism (PSY; “Having thoughts that are not your own”), and Additional dimension (AD; “Awakening in the early morning”). Each of the items is rated on a 5 -point scale of distress (0-4) ranging from "not at all" to "extremely." Three indices can be computed from the ten dimensions the Global Severity Index (GSI): Designed to measure overall psychological distress, the Positive Symptom Distress Index (PSDI): Designed to measure the intensity of symptoms and Positive Symptom Total (PST): Reports number of self-reported symptoms. The global severity index (GSI) is computed from the first summing of the scores of the nine dimensions and the additional items, and then dividing by the total number of responses (i.e., 90, unless some questions were unanswered). The positive symptom total (PST) is derived from the number of items endorsed with a positive (nonzero) response. The positive symptom distress index (PSDI) is calculated by dividing the sum of all item values by the PST.

8. 2. Body figure scale (Mouches, 1992)

In order to evaluate also explicit attitude toward the female body shapes, and different body weights we used the body figure scale created by Mouches (see Appendix 11). The scale consists of 14 female silhouettes showing the side of their figure. The figures represent increasing BMI from underweight anorexic body image (corresponding around BMI 16) to obese body image (BMI 31). Along the different studies we used this scale to test the perception of the participants on their actual body size and ideal body shape. And also we selected female figures from this scale to the implicit task (affective priming see it below) as prime stimuli in order to investigate the participant’s attitudes toward different body shapes.

9. Implicit measure

9.1. Affective priming paradigm (Fazio et al., 1986)

The affective priming paradigm is used to assess implicit attitudes toward body shape, leaning on the procedure of early attention allocation and automatic reactions when affective information presents (Fazio et al., 1986, Winkielman et al. 1997). The principle of the task is to measure whether the preliminary presented emotional stimuli (prime) would modify the processing speed and accuracy of subsequent target evaluation on positive or negative valences (Hermans et al., 2001). When the affective valence of the prime is similar to that of the target stimuli (positive-positive; negative-negative) a congruence or facilitation effect occurs, which leads to faster and more accurate responses than incongruent prime-target combination (positive-negative; negative-positive). The difference in response latencies or error percentage (accuracy) between congruent and incongruent trials is called the priming effect.

Based on other studies (Verhulst et al., 2006; Vermeulen et al., 2006) simple black and white drawings were used as primes. Participants are invited to evaluate and categorise each target word according to its value (positive vs. negative) as fast and accurate as possible by pressing left (L) or right (S) keys of an AZERTY keyboard. The task starts with 12 training trials in order to get familiar with the task. Then, the experimental part divided into three blocks of four positive and four negative adjective targets. Each of the three blocks consisted of 80 trials, resulting in a total of 240 trials. The task procedure and the timing of the trials were arranged after a previous study (Vermeulen et al. 2006). Each trial included a sequentially a fixation point, the prime lasting for 100 ms (the stimuli onset asynchrony [SOA] was 100 ms) directly replaced by the target word appearing for 500 ms. Each target was randomly preceded by one of the selected prime stimulus on the screen.

Part IV. Examinations

10. Participants

Participants were recruited in our studies from three main age-ranges, children, adolescent and adult. The onset pick of the eating disorders are very much varying. For example obesity can appear both in childhood and adulthood, while the onset of anorexia nervosa typically is in the adolescent period and the problems start at the age of 11-13. Our aim was to investigate the common mechanisms and the possible dysfunction linked to the pathological status; therefore we selected our participants from the age-ranges, which represent the most of the specific eating disorders. The table 3 present the personal and demographic data of the patients and the age- and education matched control groups. The table 3 shows that patient groups and control groups were significantly different on the BMI and the weight but not on age or education level (scholar years).

Table 3 Personal and Demographic information of all participants

Patients	*Children with obesity N=12*		*Adults with obesity N=30*		*Adolescents with anorexia N=35*	
	M(SD)	Range	M(SD)	Range	M(SD)	Range
Age	12.1(0.91)	11-13	48.8(11.01)	20-65	19.61 (3.42)	13-27
Weight (kg)	71.3(4.72)**	65-78	92.6(19.98)**	68-147	38.56(4.32)**	32-45
BMI	27.16(1.79)**	24-30	34.2(7.83)**	27-60	14.76 (1.31)**	13-17
Scholar years	5.21(0.21)	5-6	14.4(1.65)	9-17	10.45(3.5)	6-17
Controls	*Controls N=12*		*Controls N=30*		*Controls N=35*	
Age	12.44(0.51)	11-13	49.33(11.06)	20-66	20.27 (3.93)	14-27
Weight (kg)	35.58(4.01)	30-40	62.80(6.61)	52-78	54.43(4.67)	49-59
BMI	16.87(1.34)	14-19	22.84(1.70)	19-25	19.79 (1.42)	17-22
Scholar years	5.33(0.31)	5-6	14.70(1.70)	11-18	10.78(2.6)	7-17

(**) $p<0.01$, BMI = weight [kg]/ height [m]^2

10.1. Children with obesity

Twelve obese schoolboys and 12 controls boys with normal body weight were recruited for our study. The mean (±S.D.) age of the obese group, their body weight and their mean Body-Mass Index (BMI) is presented in the Table 3. In Europe ten year old boys over BMI 24 are considered obese (Joseph et al., 1997; Cole et al., 2000). Our participants with obesity had a strongly elevated BMI considering their age (minimum BMI 24; maximum 30), but otherwise they were healthy. Their clinical reports proved that apart from the increased food intake, none of them suffered from any hormonal disturbances, diabetes or genetic diseases that could explain their weight gain. Twelve healthy schoolboys participated in this examination their mean age, body weight and BMI are indicated in the Table 3. Both obese and control children came from middle class families living in an urban environment (Pécs). None of the participants' parents were unemployed or retired. There was a significant difference between the two groups in BMI ($t(24)= 15.5$, $p< 0.01$). Any psychiatric disorders, epilepsy or brain injuries were considered as exclusion criteria. All participants were right-handed native Hungarian speaking boys with normal or corrected-to-normal vision. Prior to their inclusion into the study, children gave their informal consent and in each case the written permission of parents was documented.

10.2. Adults with obesity

The participants were 30 female patients with a diagnosis of obesity seeking treatment for weight loss in Belgian specialized clinics and 30 normal body weighted female control with no diagnosis of any eating disorders or major psychiatric disorder. Apart from binge-eating induced obesity any other types of psychiatric problems like major depression, substance abuse or psychosis were exclusion criteria of the studies. Control females

were recruited by taking account to the education level of the patients and their social status. The mean age and weight of both groups and their mean body mass index (BMI = weight [kg]/ height [m] ^{2}) are presented in the Table 3. There was no significant difference in groups considering age ($t(60) = 0.06$, $p < 0.8$) but in weight ($t(60) = 20.94$, $p<0.01$) and BMI ($t(60) = 22.05$ $p<0.01$) they strongly differed. No significant differences were found between the two groups considering education level such as the number of scholar years ($t(60) = 0.57$ $p<0.45$).

We compared the two groups on social status using a 5-point scale used the profession of the participants as a measure (1 "unemployed" to 5 "executive" see Table 4) and the highest school degree measured on an other 5-point scale; (from 1 "primary school degree" to 5 "university degree"). No difference was found in the frequency between the two groups for social status and highest school degree. According to participants' clinical files and self-reported short questionnaire five participants of the obese and four of the control group were under antidepressant medication. Apart from nutrition habit and binge-eating tendency of the obese patients no hormonal changes or metabolic illness or any kind of genetic disease could explain their obesity. All participants were originated from Belgium, their native language was French and they had normal or corrected–to-normal vision.

Table 4 Comparison on the frequency of the school degree and the type of professions.

	Obese	Control
Degree		
1. Primary School	0	0
2. Technical School	1	1
3. Baccalaureate	10	9
4. College	16	17
5. University	3	3
Total (N)	30	30
Profession		
1. Unemployed	2	2
2. Student	1	1
3. Physical worker	2	2
4. Employee	23	25
5. Executive	2	0
Total (N)	30	30

10.3. Adolescent with restrictive anorexia nervosa

"The SAFE that I need that I find from dieting
my physical body may be on the line
but who would care to be healthy
if it means emotional unease?"
Lisa Arndt anorexic patient

The participants were 35 female patients with a diagnosis of anorexia nervosa of restrictive subtype hospitalized in Psychiatric clinic situated in Braine l'Alleud in Belgium and 35 normal body weighted female control with no diagnosis of any eating disorders. The diagnosis of restrictive Anorexia nervosa was made upon DSM-IV criteria (American Psychiatric Association, 1994) and by trained clinicians. Other types of eating disorders (anorexia nervosa purging type, bulimia, and binge-eating) or psychiatric problems like major depression, substance abuse or psychosis were exclusion criteria of the studies. Control females were recruited by taking into account the age and the education level of the patients. Both patients and control participants were primary, secondary or university students, none of them started yet working. The mean age of the anorexic and the control group, their weight and body mass index (BMI) is presented in the Table 3. No significant difference was found between the two groups in age ($t(70) = 0.67$ $p < 0.6$) and scholar years ($t(70) = 0.87$ $p < 0.8$) but the difference in BMI was strongly significant ($t(70) = 10.7$ $p < 0.01$). All participants were originated from Belgium. Their native language was French and they had normal or corrected–to-normal vision.

11. Materials

11.1. Neuropsychological assessment

We composed a short set of neuropsychological tests in order to assess the cognitive profiles of the children; specifically the shifting capacity and mental flexibility (see Table 5). Five different neuropsychological tests were adopted to assess the executive function and attention in adult obesity (see Table 5).

We selected five neuropsychological tasks in order to assess the performance of the patients with anorexia on memory, attention, intelligence and executive function based mental flexibility both verbal and non-verbal performance (see Table 5)

11.2. Questionnaires

The mood, alexithymia and the attitudes towards body shape and eating of the participants were measured by self-reported questionnaires (see Table 5).

11.3. Explicit body shape evaluation

Body Figure Scale (Appendix 11) was used to measure the explicit attitudes toward body shape. Participants were asked to indicate on the scale which body silhouette would correspond to their own actual body shape and which silhouette they would consider as ideal one.

11.4. Implicit measure – Affective priming task

Affective priming task was used to examine the two main hypotheses about information processing in obesity. First, we examined in the treatment of facial emotional information in adult obesity and anorexia nervosa. Second, we investigate the differences between explicit versus implicit evaluation of body shape in obesity and anorexia nervosa (see Table 5).

Treatment of facial emotional information

- Primes: Schematic faces representing happiness, sadness and anger were used as prime stimuli (see Appendix 3). Happy face was considered as positive prime, while the sad and the angry faces as negative primes. The neutral schematic face was used as a baseline in the measurement of the emotional information processing.

- Targets: Twelve positive (e.g., joyful) and 12 negative (e.g., sorrowful) French adjectives were selected as target stimuli (see Appendix 1) based on the previous study (Vermeulen et al. 2006). No differences were found for frequency of usage in the language or familiarity measured on 7 -points scale from 0 to 6 ($F [1,11] < 1$, Ns positive: M= 4.93, S.D. = 0.52; negative M= 4.80, S.D.= 0.40), and for the length of the target words ($F [1,11] < 1$, Ns., positive: M= 7.16, S.D. =1.83; negative: M= 6.83, S.D.= 0.98) There was a significant difference between positive and negative targets for valence ($F [1,11] < 157.63$, $p<0.001$; positive M= 2.17, S.D. = 0.31; negative: M= - 1.91, S.D.= 0.26).

- Procedure: The subjects had to categorise target words on positive or negative valences by pressing "L" or "S" key on the computer. Each target word was anticipated by a very shortly displayed schematic face prime stimulus. The schematic faces were presented in a random order on the computer display. Participants were asked to perform as quick and as accurate on the task as possible. The reaction times (RT) of the participants were registered in Excel files. We calculated upon the RT of the participants the inhibition, facilitation and the priming effects for each of the face primes in the following way.

  Inhibition: Mean RT (neutral prime/positive target - negative prime/positive target) or mean RT (neutral prime/negative target – positive prime/negative target).

  Facilitation: Mean RT (neutral prime/positive target - positive prime/positive target) or mean RT (neutral prime/negative target – negative prime/negative target).

Priming effect: Congruent prime-target combinations (mean RT [negative prime/negative target]; RT [positive prime/positive target]) were subtracted from the incongruent prime-target combinations (mean RT [negative prime/ positive target]; RT [positive prime/negative target]).

Implicit evaluation of body figure

- Primes: In the body image evaluation to establishing ideal female body shape, we conducted a pre-test with the participation of 62 university students (age M=22.49, SD±5.36, BMI M=20.52, SD±1.36) who were asked to evaluate 14 different female body figures from the Body Figure Scale on a 6-points Likert scale from -3 to 3 scores. The university students selected two female silhouettes as ideal (the number 3 and 4 see appendix 11) and we used the number 3 as ideal prime (number 3). In the study with obese patients we used the underweight anorexic (number 1), the overweight (number 10), the obese (number 14) and the normal figures as prime stimuli (see Appendix 5).
  In the study with anorexic patients we used the underweight anorexic (number 1), the overweight (number 10) and the normal figures as prime stimuli (see Appendix 4).

- Targets: The same twelve positive (e.g., joyful) and 12 negative (e.g., sorrowful) French adjectives were used as target stimuli (see Appendix 1) than in the previous implicit task.

- Procedure: The subjects had to categorise target words on positive or negative valences by pressing “L” or “S” key on the computer. Each target word was anticipated by a very shortly displayed prime stimulus. The underweight, ideal, overweight and obese female figures were presented in a random order on the computer display. Participants were asked to perform as quick and as accurate on the task as possible. After completing the task the participants were asked to rank the four body figures one after the other on 7 point Likert scale rating

between 1 (absolutely negative) to 7 (absolutely positive). We calculated the priming effects for each of the primes in the following way:

Priming effect: Congruent prime-target combinations (mean RT [negative prime–negative target]; RT [positive prime–positive target]) were subtracted from the incongruent prime-target combinations (mean RT [negative prime-positive target]; RT [positive prime- negative target]). Underweight and ideal silhouettes were considered as positive and overweight and obese silhouettes as negative primes.

Table 5 Tasks and questionnaires used in the different groups.

	Children with obesity	**Adults with obesity**	**Adolescents with anorexia**
Neuropsychological tasks			
The Digit Span memory test	X	X	X
Raven intelligence test	X		X
Verbal Fluency test	X	X	X
D2 attention endurance test	X	X	X
Wisconsin Card Sorting test	X		X
Trail Making Test		X	
Hayling Sentence Completion task		X	
Questionnaires			
Beck Depression Inventory		X	X
Trait-State Anxiety Inventory		X	X
Toronto Alexithymia Scale		X	X
Eating Disorder Inventory		X	X
Symptom Check List 90-R		X	X
Negative Affectivity and Positive Affectivity Schedule		X	
Explicit body evaluation		X	X
Affective priming			
Face primes		X	X
Silhouette primes		X	X

12. Procedure

Neuropsychological testing

Each test battery was sensitive tools, to measure different cognitive functions like PFC based mental flexibility and set-shifting capacity, attention endurance, working memory, and intelligence in the participants.

The participants were asked to perform each cognitive test individually. The examination was carried out with the same examiner and it required about one hour for each child.

Questionnaires

Two testing session was organised each of them lasted around one hour. Along the first session the participants filled up the questionnaires and completed the neuropsychological tasks in random orders.

Implicit task

Each participant performed individually on the tasks and they could take a short break when they felt tired. Along the second session participants were asked to complete the affective priming task. The protocol of Affective priming task was created on E-prime 1.1.4.1. version and stimuli were presented on Siemens Fujitsu notebook with a 15 inches LCD monitor (60Hz). Response latencies of the participants were registered and analysed applying Excel and SPSS 13.0 statistical program. For analysing the data of the affective priming task we ANOVA repeated measure and the following designs were applied:

- 3 (nature of faces: happy vs. sad vs. angry) x 2 (valence of the targets: positive vs. negative) x groups (obese vs. control). Two first factors as within subject and the group as between subject factors.
- 3 (nature of faces: happy vs. sad vs. angry) x 2 (valence of the targets: positive vs. negative) x groups (anorexic vs. control). Two first factors as within subject and the group as between subject factors

- 4 (nature of silhouette primes: underweight vs. ideal vs. overweight vs. obese silhouettes) x 2 (valence of targets: positive vs. negative) x group (obese vs. control). Two first factors as within subject and the group as between subject factors.
- 3 (nature of silhouette primes: underweight vs. ideal vs. overweight silhouettes) x 2 (valence of targets: positive vs. negative) x group (anorexic vs. control). Two first factors as within subject and the group as between subject factors

13. Results

13.1. Excessive eating (obesity)

1. Hypothesis about the executive dysfunction in obesity

1.1. The group comparisons on each of the five neuropsychological tests were first performed applying t-test. Table 6 shows descriptive statistics with mean and p values of the subscales of all the five cognitive tasks for obese and controls groups. The obese and healthy-weight boys did not differ significantly in mean scores for forward ($p<0.7$) or backward digit span ($p < 0.5$), on the intelligence, assessed by Raven test ($p<0.8$). The interaction of the groups x fluency category was not significant for none of the three categories (animal: $F (1, 22) = 0.07$, $p <0.8$; fruit: $F (1, 22) = 0.17$, $p <0.7$; professional and suits alternation: $F (1, 22) = 0.09$, $p <0.8$). Significant group difference was found on number of **correct responses** ($F (1, 22) = 6.19$, $p <0.03$) of **the D2 attention test** and the groups and global attention interaction was marginally significant ($F (1, 22) = 3.8$, $p<0.06$). As far as the WCST is concerned, the groups and WCST error types interaction was significantly different on total committed errors ($F (1, 22) = 5.71$ $p<0.03$); the **number of perseverative responses** ($F (1, 22) = 6.94$, $p<0.02$) and **perseverative errors** ($F (1, 22) = 6.08$, $p<0.03$). The number of trials made during the WSCT task and the group interaction was marginally significant ($F (1, 22) = 4.27$, $p <0.06$).

Table 6 The performance of the obese and normal body weight control children on the neuropsychological test.

Tasks	**Obese** Mean (S.D.)	**Control** Mean (S.D.)	**P>**
Digit span Forward	5.67(1.3)	5.58 (0.51)	0.68
Digit span Backwards	3.92(0.99)	4.17(0.57)	0.46
Raven test	39.58(6.16)	38.42(5.31)	0.73
Semantic Verbal fluency	10.33(3.11)	10.50(2.23)	0.76
D2 test Global	381.08(73.70)	423.1(46.69)	0.06
D2 test Errors	28.25(20.20)	31.84(28.10)	0.91
D2 test Correct responses	343.42(63.52)*	385.92(47.7)	0.02
WCST Trial	105.92(25.06)	91.66(22.61)	0.06
WCST Total correct responses	54.25(6.11)	56.75(8.75)	0.56
WCST Total errors	51.67(24.78)	34.91(18.63)	0.03
WCST Perseverative responses	27.08(15.84)*	15.58(7.85)	0.02
WCST Perseverative errors	24.17(14.75)*	14.83(7.50)	0.02
WCST Non-perseverative errors	27.00(12.01)	20.00(12.47)	0.07

Asterisks show significant differences (*) p<0.05,

Table 7 presents Pearson's correlation between the neuropsychological tasks, body weight and BMI. The **perseverative responses** of the WCST were positively correlated with **BMI** (r= 0.41) and body weight (r=0.45). A negative significant relationship was found between **D2 correct responses and BMI** (r = -0.43) and body weight (r=-0.48).

Table 7 The relationship between body weight, BMI and cognitive functioning.

Tasks	**BW**	**BMI**
Digit Span forward	0.09	0.07
Digit Span backward	-0.11	-0.15
Raven's test	0.02	-0.02
Semantic Verbal fluency	-0.11	-0.09
D2 correct responses	-0.48*	-0.43*
WCST trials	0.33	0.32
WCST perseverative responses	0.45*	0.41*
WCST perseverative errors	0.42	0.38
WCST non-perseverative errors	0.32	0.35

BW=body weight, Asterisks show significant r-value (*) p<0.05.

1.2. We compared the cognitive performances of the two groups by using ANOVA. Table 8 summarize the results of each neuropsychological test. No differences were found on Digit Span and Semantic and Phonetic Verbal Fluency tasks between the two groups. Similarly the previous examination with obese children, obese female patients performed significantly worst on the **D2 attention test** when **correct responses** were measured (F (1, 58) = 4.29 p<0.04) but there was no significant difference between groups for the D2 global capacity. The obese patients performed also significantly slower on the **A part of the TMT** (F (1, 58) = 5.23 p<0.03) but not on the part B (F (1, 58) =2.50

p<0.12) or the difference speed between Part A and B (F (1, 58) = 0.53 p<0.47). The results of the other task measuring the executive function, Hayling test revealed significantly slower performance in the obese group than in the control **both for the part A, B and** also the **B-A** (Part A, F (1,58) = 16.43, p<0.00, part B F(1,58) = 7.86 p<0.01, B-A F (1,58)= 5,14 p<0.03). Considering the accuracy (i.e. number of errors) of the TMT and Hayling tasks there was no difference between the two groups.

Table 8 The performance of the obese and control participants on the neuropsychological tasks

	Obese M (SD)	Control M (SD)	df	F	p>
Digit Span	5.4 (1.1)	5.8(1.1)	1, 58	1.88	0.17
Digit Span forward	4(0.9)	4.4(0.8)	1, 58	2.29	0.13
Verbal Fluency Semantic	18.3(3.6)	18.9(2.8)	1, 58	0.72	0.40
Verbal Fluency Phonetic	9.3(2.5)	9.6(2.6)	1, 58	0.25	0.62
D2 attention global capacity	425.8(86.4)	457.1(84.7)	1, 58	2.01	0.21
D2 correct answers	141.9(36.2)*	162.2(39.6)	1, 58	4.29	0.04
TMT A time	31.5(9.6)*	26.2(8.2)	1, 58	5.23	0.03
TMT A error	0.2(0.4)	0.1(0.4)	1, 58	0.31	0.58
TMT B time	71.7(23.4)	63.6(15.6)	1, 58	2.50	0.12
TMT B error	0.2(0.5)	0.3(0.5)	1, 58	1.63	0.21
TMT B-A	40.2(17.7)	37.3(12.2)	1, 58	0.53	0.47
Hayling A time	42.9(7.2)**	37.3(2.3)	1, 58	16.43	0.00
Hayling error	0.1(0.3)	0.1(0.2)	1, 58	1.05	0.31
Hayling B time	154.2(51.7)**	123.2(31.3)	1, 58	7.86	0.01
Hayling B error	5.1(2.9)	5.2(2.9)	1, 58	0.01	0.93
Hayling B-A	111.3(52.9)*	85.9(31.0)	1, 58	5.14	0.03

. TMT= Trail Making Test, *Asterisks indicate the significant differences between the two groups* (*) p<0.05, (**) p<0.01

Table 9 shows the correlation between the neuropsychological tests and personal data such as BMI and Body weight. There were correlation between the **BMI and the D2 correct responses** (r= -0.28 p<0.04), TMT A (r=0. 36 p<0.02) and **Hayling A** (r= 0.46 p<0.01) and **Hayling B** (r=0.29 p<0.04).

Table 9 The correlation between the neuropsychological tests, body weight and BMI.

	BW	BMI
Digit Span forward	-0.29	- 0.22
Digit Span backward	-0.16	-0.20
Semantic Verbal Fluency	-0.10	-0.11
Phonetic Verbal Fluency	-0.06	-0.07
D2 correct responses	-0.30*	-0.28*
TMT A time	0.36*	0.36*
TMT B time	0.24	0.25
TMT B-A	0.10	0.12
Hayling A	0.48**	0.46*
Hayling B	0.30*	0.29*
Hayling B-A	0.24	0.24

BW=Body weight, Asterisks indicate significant differences (*) p<0.05, (**) p<0.01.

2. Hypothesis about the relationship between negative mood and obesity.

2.1. **Significantly higher levels of depression** (BDI, F (1, 58) = 22.38, p<0.00; SCL-90-R DEP, F (1, 58) = 12.18, p< 0.00) and of **state anxiety** (STAI; F (1, 58) = 10.37, p<0.00) were found in the obese group than in the control group (See figure 4). However, there was no significant difference between the groups for the general anxiety measured by trait dimension (STAI-TRAIT and SCL-90-R, ANX) and negative or positive mood (PA-NAS) either.

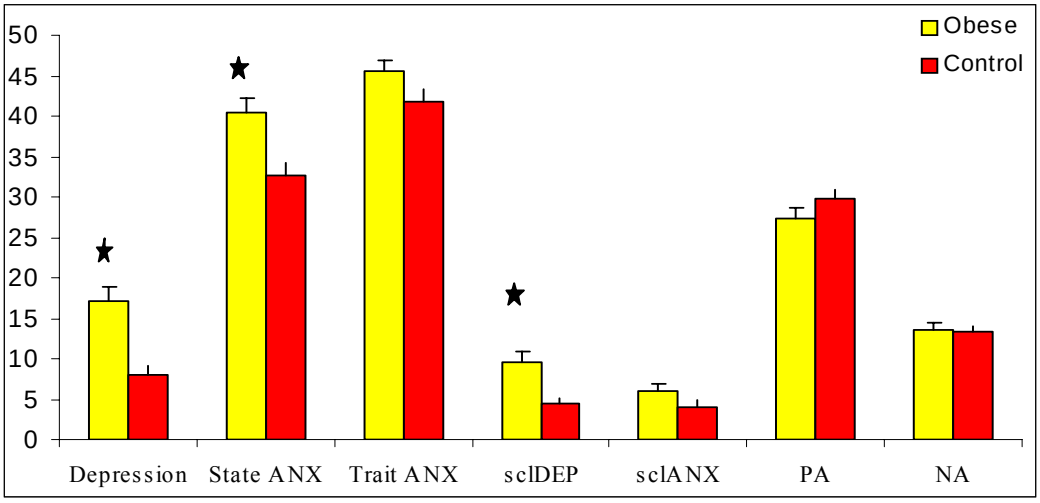


Figure 4 Summary of the results on the questionnaires measuring emotional functioning in obese and control groups. SEM is indicated with error bars. The asterisks show significant group differences (p<0.01). ANX=anxiety, sclDEP= depression scale on SCL 90, sclANX= Anxiety scale on SCL 90, PA= positive affectivity, NA= negative affectivity

2.2. Partial correlation (controlling for groups) revealed that the **severity of depression** both assessed by BDI (r=0.50 p<0.01) and assessed by SCL 90 (sclDEP r=0.30 p<0.03) was **related positively to the BMI**. Neither trait nor state anxiety was correlated with the BMI.

2.3. The three indices of the SCL-90-R (see Table 10), the GSI (p<0.00), the PSDI (p<0.02) and PST (p<0.00) indicating the **level of distress were significantly higher in the obese group.**

Table 10 Group differences on the 90-item symptom check

SCL 90-R	**Obese M (SD)**	**Control M (SD)**	**df**	**F**	**p>**
GSI	0.7 (0.4)**	0.4 (0.3)	1.58	10.41	0.00
PSDI	40.1 (14.5)*	29.6(20.1)	1.58	5.40	0.02
PST	1.1 (0.6)**	0.6 (0.6)	1.58	10.13	0.00

P values in bold characters show the significant differences, SCL-90-R= Symptom Check List (*) p<0.05, (**) p<0.01

3. Hypothesis about the possible relationship between negative mood and cognitive performance in obesity

Partial correlation controlling for group were carried out on the results of neuropsychological tasks, depression, affectivity and anxiety. There was a **positive correlation** between **positive affectivity scores** (**PA**) and the **performance on the D2 attention** task (global attention capacity r=0. 36 p <0. 01; correct responses r=0. 43 p <0. 01). Positive correlation was found between PA and **semantic verbal fluency** task (r=0. 26 p <0. 05); PA and **Digit Span backward** (r=0. 42 p <0. 01), while **PA negatively correlated with the TMTB** (time, r=-0. 27 p <0. 05). However, **depression, anxiety** and negative affectivity **did not correlate** with any of the five **neuropsychological tasks**. Partial correlation controlling for depression and anxiety revealed that BMI positively correlated with TMT time (TMTA, r=0. 31 p <0. 02; TMTB, r=0. 28 p <0. 03) and of the Hayling test (A, r=0. 31 p <0. 02; B, r=0. 25 p <0. 05). Linear regression confirmed that the depression and the Hayling test can be associated with obesity. (R=0. 66, Rsquare= 0. 43, F=14. 11, p <0. 01; depression F=-3. 51, p <0. 01, Hayling B F=-3. 51, p <0. 01, Hayling AB F=3. 26, p <0. 01).

4. Hypothesis about alexithymia and its relation to mood in obesity.

4.1. Considering alexithymic personality feature (TAS-20) apart from that obese patients showed **significantly more difficulty on the identifying emotion** subscale (F (1, 58) = 4.57, p<0.04) there was no significant difference between the two groups.

A series of ANCOVAs and partial correlation were used to examine the possible relationship between depression, anxiety (trait), negative affectivity (NA), BMI

and the three factors of alexithymia (see Table 11). The results show that **depression and anxiety contributed to the level of the alexithymia**. Depression (BDI, r=0.42 p<0.01; sclDEP, r=0.40 p<0.01), trait anxiety (r=0.46 p<0.01) and NA (r=0.36 p<0.01) had a moderating effect on the „difficulty identifying feelings" subscale of Toronto Alexithymia Scale. Depression (BDI, r=0.30 p<0.03) and trait anxiety (r=0.38 p<0.01) positively influenced the alexithymia score of the subjects. Most probably the higher score on the "difficulty on the identifying emotion" subscale in the obese group was linked to the negative mood.

Table 11 The summary of ANCOVA results examining the relationship between the dimension of alexithymia and the groups controlling for depression, anxiety, negative affectivity and BMI.

Dependent variables	Depression (BDI)	Anxiety (trait)	Negative Affectivity	BMI
TAS- Dif. Identifying feelings	12.17 (0.01)**	9.30 (0.01)**	8.25 (0.01)**	1.25 (0.26)
TAS –Dif. Expressing feelings	0.01 (0.90)	4.25(0.04)*	0.65 (0.45)	0.14(0.70)
TAS- Externally oriented thinking	2.08 (0.58)	0.64 (0.45)	1.01 (0.30)	0.38(0.54)
TAS -Alexithymia	5.30 (0.02)*	6.64 (0.01)**	2.38 (0.19)	0.09(0.90)

(*) p<0.05, (**) p<0.01

5. Hypothesis about the treatment of facial emotional information in obesity

5.1. Response latencies (RL) associated with corrects responses either too fast (300 ms) or too slow (1500 ms) or erroneous ones were erased (see Table 12). Affective priming paradigm was analysed by the interaction between the valence of target and prime stimuli in both group. Our result reported on response latency (speed) while no differences were found on response accuracy (number of errors). There was no significant difference for groups in general response speed considering all targets (t (60) = 0.71, p< 0.27).

Table 12 Mean reaction times (msec) in the groups together with the standard deviations (SD) for schematic faces

	Target Valence	Happy face (SD)	Sad face (SD)	Angry face (SD)	Neutral face (SD)
Obese group	positive	760.9(103.6)	791.3(131.2)	819.2(128.0)	816.3(142.0)
	negative	831.2(160.1)	813.6(126.9)	832.6175.0)	828.6(119.5)
Control group	positive	766.6(110.9)	778.8(117.6)	780.9(111.1)	748.6(95.9)
	negative	797.2(108.7)	781.4(106.0)	790.2(125.0)	796.3(127.7)

Repeated measure of ANOVA revealed an **interaction between targets and face** primes ($F(2, 58) = 3.62$, $p<0.04$) within subject, which means that the emotional faces influenced differently the reaction times on the targets. Paired t-test revealed the differences between **inhibition and facilitation effect in the obese group for the happy face** ($t(30) = 2.11$, $p<0.05$ see figure 5) and **in the control group for the angry face** ($t(30) = 2.40$, $p<0.03$). Comparing the two groups on the facilitation and inhibition effects we have found significant difference for the **facilitation effect of the happy face** ($t(60) = 2.30$, $p<0.03$), and for the **inhibition effect of the sad face** ($t(60) = 2.50$ $p<0.02$) and of the **angry face** ($t(60) = 2.02$ $p<0.05$). These results suggest that obese patients treated faster the happy face (positive emotions), while control group the angry face (negative emotion).

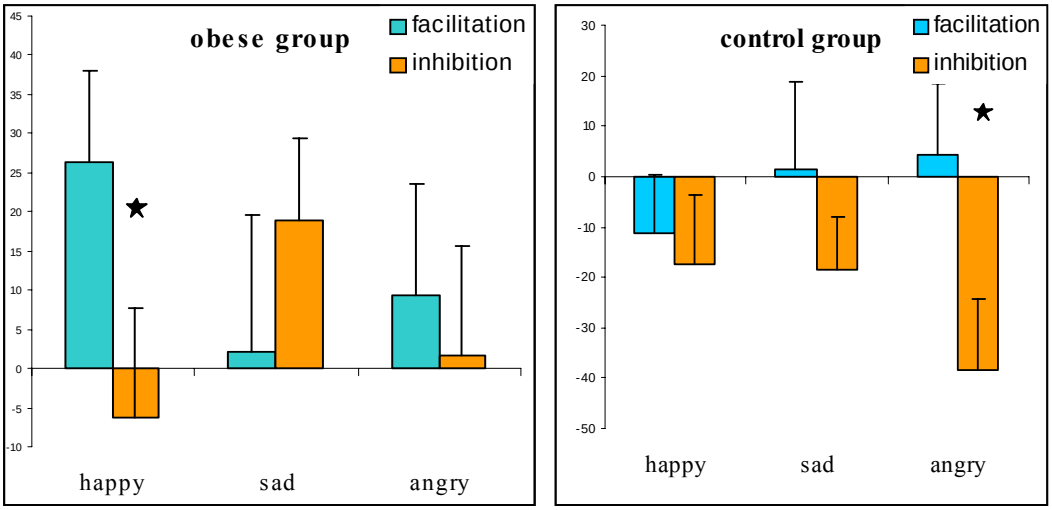


Figure 5 Facilitation and inhibition effects in the obese and the control group on faces expressing different emotions used as a prime. Asterisks show significant differences, SEM is indicated with error bars.

Regarding the overall priming effect on the three different emotions we did not find significant differences between the two groups because of the high variability of the reaction times (see figure 6).

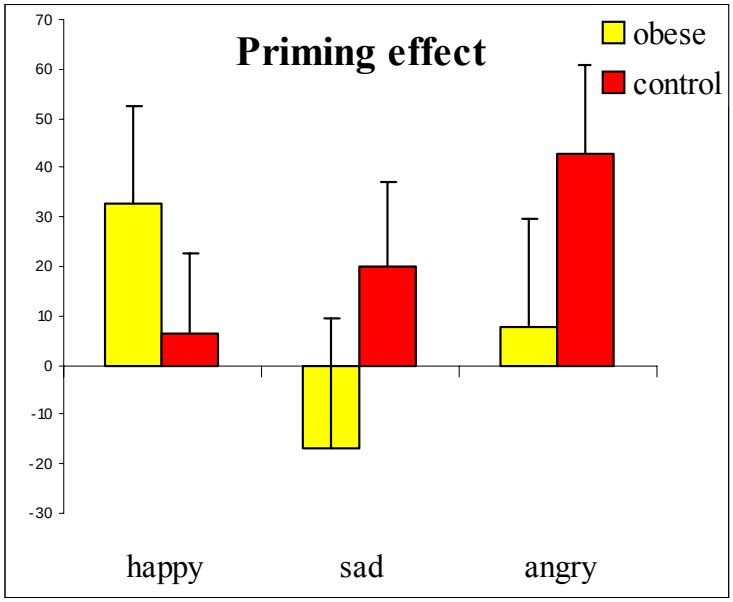


Figure 6 Priming effect in both group for the three different emotions (happy, sad, angry). SEM is indicated with error bars.

5.2. **Depression had an influence** on the treatment speed of the primes generally ($F(2, 58) = 4.32$, $p<0.02$) and on the groups ($F(2, 58) = 4.26$ $p<0.02$). It suggests that depression contributed to the treatment of the primes between groups but not within groups. Psychological distress measured by the three indexes of the SCL-90-R and anxiety did not contribute to the treatment of the emotional information.

5.3. The possible influence of alexithymia on the interaction between targets and face primes was controlled with ANOVA repeated measure. **Alexithymia contribute to the interaction between prime and targets within groups** but not between groups. The interaction between prime x target x difficulty identifying feelings subscale ($F(2, 53) = 3.69$ $p<0.03$), prime x target x difficulty describing feelings ($F(2, 53) = 3.34$ $p<0.05$) and prime x target x externally oriented thinking ($F(2, 53) = 4.13$ $p<0.02$) and prime x target x Alexithymia ($F(2, 53) = 3.79$ $p<0.03$). Partial correlation controlling for group and depression revealed the positive relationships between facilitation effect of the sad face and the difficulty describing feelings subscale ($r=0.26$ $p<0.05$) and between the facilitation effect of angry face and the externally oriented thinking subscale ($r=0.28$ $p<0.04$).

6. Hypothesis about perceptual and attitudinal aspects of the body image in obesity

6.1. Explicit attitudes toward body shapes were measured on the Body Figure Scale (see Appendix 11). We measured the discrepancy between the perceived body image and the real body weight. There was a **significant difference between the two groups for body image perception** ($F(1, 55) = 36.44$ $p<0.00$) as the Figure 7 shows the participants from the obese group underestimated their own body shape. The more the participants' real BMI was elevated the discrepancy between perceived and real BMI was bigger. The results of the three females with sever obesity (< 45) is not considered as the last (14) figure from Body Figure Scale represents a much lower BMI (~ 31) therefore they could not indicate their own body shape on the scale.

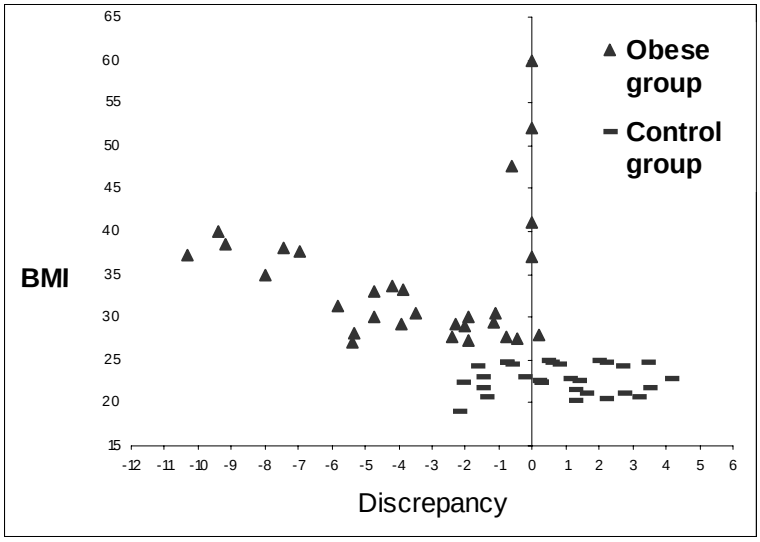


Figure 7 Discrepancy between the perceived BMI on the Body Figure Scale and the real BMI.

6.2. Participants were asked to indicate on the body figure scale the body figure that they would consider as ideal shape. We have found **no group differences** ($F(1, 58) = 1.3$, $p<0.26$), both obese and control group indicated similar body shape as ideal figure. Pearson correlation showed that the **severity of the depression was positively linked to the distance between the number of the ideal body figure selected on the scale and the actual body figure size** ($r=0.47$ $p<0.01$).

6.3. Measuring the attitudes towards body shapes and eating behaviours on the Eating Disorder Inventory obese patients scored higher on body dissatisfaction than

control group (p<0.00, see Table13). The general **eating disorder attitudes were correlated with depression** in both groups (EDI, r=0.53 p<0.01). However, body dissatisfaction and drive for thinness dimensions were related to the depression only in the control group but not in the obese group. There was a positive correlation between the level of the **body figure underestimation (discrepancy between perceived and real BMI) and the severity of the depression in the obese group (r=0.51 p<0.01).**

Table 13 The group differences on the Eating Disorder Inventory (EDI) and its eight dimensions measuring personality and attitudinal factors related to eating disorders.

Eating Disorder Inventory	**Obese M(SD)**	**Control M(SD)**	**df**	**F**	**p>**
Eating Disorder	53.4 (23.6)**	27.2 (15.1)	1.58	26.27	0.00
Drive for thinness	10.1 (4.9)**	4.2 (4.8)	1.58	21.75	0.00
Bulimia	3.3 (1.1)*	4.9 (1.9)	1.58	4.99	0.03
Body Dissatisfaction	*18.9 (7.1)***	*9.6 (6.5)*	*1.58*	*28.13*	*0.00*
Ineffectiveness	5.0 (4.7)**	2.3 (2.3)	1.58	7.93	0.01
Perfectionism	4.8 (4.3)	3.9 (3.5)	1.58	0.84	0.36
Interpersonal distrust	3.3 (3.1)**	1.5 (1.5)	1.58	8.81	0.00
Interoceptive Awareness	4.2 (4.6)*	2.0 (2.6)	1.58	4.95	0.03
Maturity Fear	3.9 (4.3)	2.4(1.6)	1.58	3.12	0.08

(*) p<0.05, (**) p<0.01

6.4. Considering explicit attitudes toward prime body silhouettes measured on the 7 point Likert scale after affective priming task the obese group and the control group judged similarly the body figures. Implicit attitudes toward body silhouettes were measured by the computed result of the affective priming tasks. Response latencies (RL) associated with corrects responses either too fast (300 ms) or too slow (1500 ms) or erroneous ones were erased (see table 14). Affective priming paradigm was analysed by the interaction between the valence of target and prime stimuli in both group. Our result reported on response latency (speed) while no differences were found on response accuracy (number of errors).

Table 14 Mean reaction times (msec) in the groups together with the standard deviations (SD)

	Target Valence	Underweight (SD)	Ideal (SD)	Overweight (SD)	Obese (SD)
Obese group	positive	774.1(101.2)	768.9(125.4)	759.1(119.2)	807.0(114.8)
	negative	813.6(131.1)	821.7(124.3)	812.2(113.6)	832.1(135.1)
Control group	positive	750.5(113.2)	744.6(90.4)	755.2(109.1)	789.9(99.1)
	negative	782.9(101.1)	770.0(94.6)	772.6(98.2)	770.3(104.9)

Repeated measure ANOVA between subject analyses revealed no group effect for interaction between the primes and the targets either for the four silhouettes ($F(1, 57) = 1.29$, $p < 0.26$). Figure 8 shows the means response latencies for the different silhouettes primes separated in the two groups. There was a **significant interaction between primes and the targets within subject** ($F(3, 57) = 3.57$; $p < 0.02$), it means that the reaction time on the targets were influence by the nature of the primes. As the figure 8 indicates the obese and control group reacted differently on the overweight and the obese silhouettes. Paired t-test revealed **significant differences only in the obese group for the negative and the positive target valences anticipated by underweight** (obese, $t(30) = 2.59$ $p < 0.02$), **ideal silhouettes** (obese, $t(30) = 3.70$ $p < 0.01$) and **overweight silhouette** ($t(30) = 2.84$ $p < 0.01$ see figure 8). Control group evaluated implicitly body figures less positive than obese group.

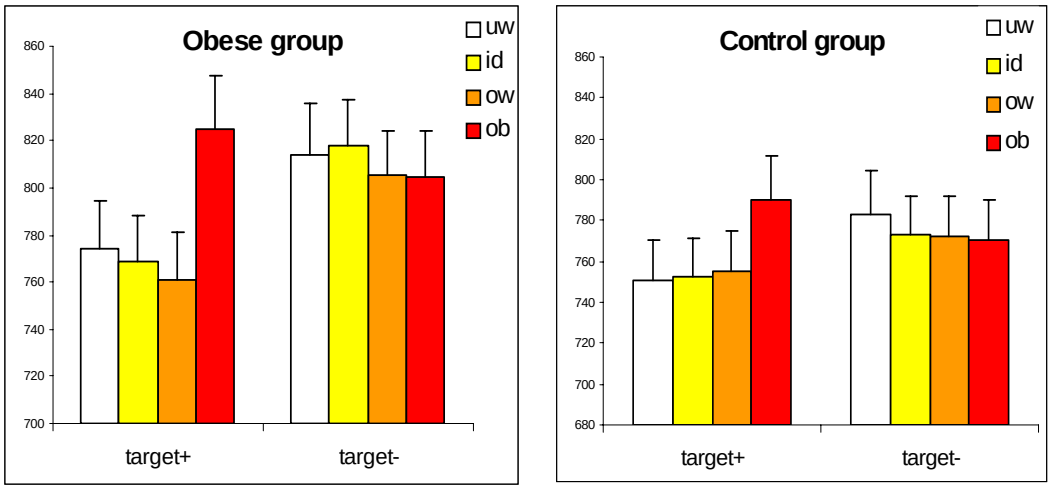


Figure 8 Mean response latencies in the obese and the control group on different body silhouettes used as a prime. uw= underweight, id= ideal figures, ow= overweight figure, ob= obese figure. (*) p<0.05 SEM is indicated with error bars

Figure 9 show the computed priming effect by subtracted the congruent combinations (positive/positive; negative/negative) from the incongruent prime and target combination (positive/negative). In contrary to our prediction the **overweight body figure was not evaluated negatively** by any of the groups. Therefore, figure 9 indicates the priming effect for overweight body figure under the zero line.

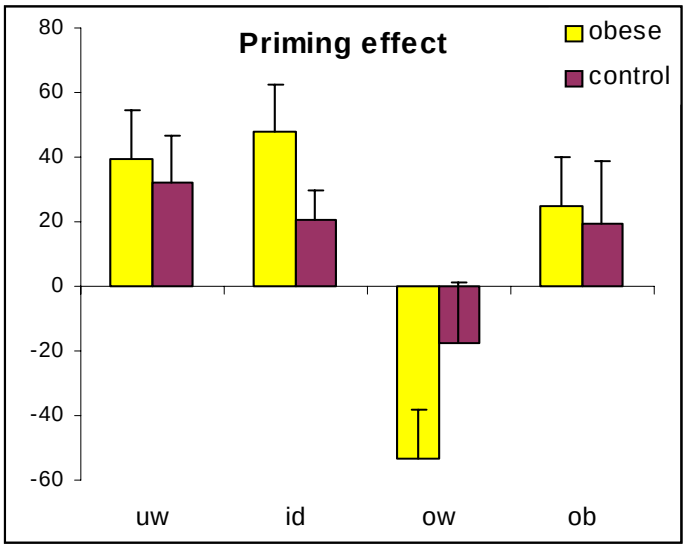


Figure 9 Computed priming effect for each body silhouette prime. uw= underweight, id= ideal figures , ow= overweight figure, ob= obese figure

13.2. Restrictive eating (restrictive anorexia nervosa)

7. Hypothesis about the possible deficit on executive functioning in anorexia nervosa

We analysed the cognitive performances of the two groups applying one-way ANOVA probe. The summary of the results is presented in the Table 15. A significant difference was found between the two groups on global attention ($F(1, 56) = 8.42$, $p > 0.01$) and correct responses ($F(1, 56) = 5.37$, $p > 0.03$) measuring attention capacity. In contrary to our expectation **no differences were found between AN group and control on perseveration and verbal fluency**, it means that executive function deficit could not be demonstrated in this study. Regarding **WSCT failure to maintain sets** dimension, AN patients performed poorer than control group, even if the difference was close to significant level ($p > 0.06$).

Table 15 The performances of the anorexic and control groups on the neuropsychological tasks.

	Anorexia M(SD)	Control M(SD)	df	F	p>
Digit Span	6.7 (1.2)	6.5 (0.9)	1,59	0.26	0.62
Digit Span forward	5.1 (1.5)	5.2 (1.1)	1,58	0.09	0.77
Raven's test	49.7 (5.2)	51.9 (5.7)	1,57	1.16	0.29
Verbal Fluency Semantic	20.3 (2.4)	19.7 (3.8)	1,59	0.23	0.63
Verbal Fluency Phonetic	10.7 (2.9)	9.1(2.5)	1,59	1.85	0.18
D2 attention global capacity	445.0 (89.7)*	524.7(62.3)	1,56	8.42	0.01
D2 correct responses	168.2(42.4)*	200.9 (37.8)	1,56	5.37	0.03
Wisconsin Card Sorting Test					
Trials	4.6 (1.9)	5.2 (1.2)	1,59	1.14	0.29
Perseverative responses	8.4 (7.7)	5.6 (5.5)	1,59	1.34	0.26
Perseverative errors	14.8 (9.6)	11.0(8.6)	1,59	1.29	0.26
Non-perseverative errors	12.6(15.9)	7.8 (6.8)	1,57	1.13	0.30
Failure to maintain set	1.5(1.4)	0.6 (1.0)	1,59	3.85	*0.06*

Asterisks show significant differences between the two groups, while italic indicates a tendency. (*) p<0.05, (**) p<0.01

The correlation in the Table 16 shows a **positive relationship between BMI, Body weight and D2 global attention capacity.** Negative correlation was found between the Phonetic Verbal Fluency test the BMI and BW. Correlation was carried out separately in the groups. Surprisingly, in the control group BMI was positively correlated with the perseveration (r=0.61 p<0.05). We believe that this correlation does not occur in the AN group because there is not enough variance in the BMI to find a significant relationship. It should be mentioned the relationship among the neuropsychological tests were found such as the Phonetic Verbal Fluency positively related to 'Failure maintaining set' subtest of the WCST (r=0.51 p<0.01), D2 correct responses correlated with Digit Span forward (r=0.37 p<0.04) and perseverative errors of WSCT (r=-0.38 p< 0.04).

Table 16 The relationships between the neuropsychological tests, BMI, and body weight BW=body weight.

	BW	BMI
Digit Span forward	0.03	0.10
Digit Span backward	0.14	0.11
Raven's test	0.02	0.11
Semantic Verbal fluency	-0.09	-0.14
Phonetic Verbal fluency	-0.28*	-0.33*
D2 global capacity	0.36*	0.35*
D2 correct responses	0.23	0.24
WCST trials	0.08	0.15
WCST perseverative responses	0.08	-0.03
WCST perseverative errors	0.04	-0.05
WCST non-perseverative errors	-0.19	-0.16
Failure maintaining set	-0.08	-0.16

Asterisks indicate significant values (*) p<0.05,

8. Hypothesis about the relationship between mood and cognitive performance

The patients with anorexia nervosa reported **significantly more depression** (BDI; F (1, 65) =44.73, p<0.00; sclDEP, F (1, 60) =16.22, p<0.00). They showed also more both **state** (STAI-STATE F (1, 65) =19.54 p<0.00) and **trait anxiety** (STAI-TRAIT, F (1, 65) =8.67 p<0.01, SCL-90-R ANX F (1, 60) = 9.28, p<0.01 see figure 10). Regarding the severity of the depression, 37% of the patients were suffering from severe and 37% from moderate depression in the AN group, while none of the healthy participants had severe and only 8% reported moderate depression in the control group. In the AN group, **higher trait anxiety predicted more perseveration in the WCST** (perseverative responses and perseverative errors; r=0.65 p<0.03). **Depression did not contribute to the cognitive performance in any of the group**s. Perfectionism did not contribute to the cognitive performance in none of the groups.

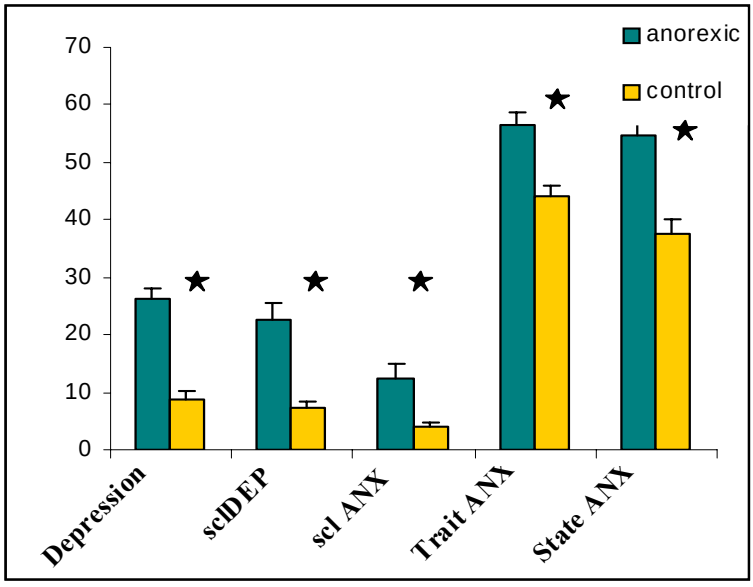


Figure 10 Summary of the results on the questionnaires measuring mood and anxiety in anorexic and control groups. SEM is indicated with error bars. The asterisk indicate significant group differences (p<0.01).

9. Hypothesis about the role of alexithymia in anorexia nervosa

9.1. The findings revealed **more alexithymia** (F (1, 65) =7.48, p<0.01) in the **anorexic group**. Anorexic group scored significantly higher on each subscale of the TAS20 (see Table 17).

Table 17 Group comparison on subscales of the TAS20.

Alexithymia	Anorexia M(SD)	Control M(SD)	df	F
TAS- Dif. Identifying feelings	20.96 (6.9)**	16.15 (6.9)	1,58	2.98
TAS –Dif. describing feelings	14.88 (4.1)*	12. 21(4.4)	1,58	2.32
TAS- Externally oriented thinking	19.44 (4.8)*	16.51 (4.5)	1,58	2.35
TAS -Alexithymia	55.36 (10.4)**	44.91(10.8)	1,58	3.76

Asterisks indicate significant values (*) p<0.05, (**) p<0.01

9.2. A series of ANCOVAs were carried out to examine the potential influence of depression, anxiety (trait), and BMI on the relationship between group membership and the alexithymia. The results show that controlling for either depression or anxiety contributed to alexithymia scores on the „difficulty identifying feelings" subscale of TAS20. It means that **depression, anxiety** separately as covariant **was highly associated with the level of alexithymia** in the groups (see Table 18). Partial correlation controlling for the groups confirmed the positive relationship between depression and alexithymia (TAS r=0.36, p<0.02) and between trait anxiety and alexithymia (TAS r=0.34, p<0.03). Furthermore we have found a strong positive link between **alexithymia and the level of distress assessed** by SCL90 (r=0.44, p<0.01). Partial correlation controlling for depression and anxiety together reinforced the hypothesis that alexithymia in AN is due to the depressive status of the patients.

Table 18 Summary of ANCOVA results on the relationships between the alexithymia, depression, anxiety and BMI.

Dependent variables	Depression	Anxiety	BMI
TAS- Dif. Identifying feelings	7.10(0.01)**	7.29 (0.01)**	0.13(0.89)
TAS –Dif. describing feelings	3.44(0.07)	2.46(0.12)	1.33(0.25)
TAS- Externally oriented thinking	0.02(0.90)	2.73(0.11)	0.49(0.49)
TAS -Alexithymia	4.97(0.03)*	8.38(0.01)**	0.00(0.98)

Asterisks indicate significant values (*) p<0.05, (**) p<0.01

10. Hypothesis about the treatment of the facial emotions

10.1. Reaction time (RT) associated with corrects responses either too fast (300 ms) or too slow (1500 ms) or erroneous ones were erased. Affected priming task was analysed by the interaction between the valence of target and prime stimuli in both group. Our result reported on response latency (speed) while no differences were found on response accuracy (number of errors). Table 19 shows the mean reaction times for each emotional faces used as prime in the examination. We did not find any significant difference for groups in general response speed considering all targets (t (68) = 0. 73, p <0. 47).

Table 19 The mean reaction times in anorexic and control groups for the schematic face primes

	Target valence	Happy face (SD)	Sad face (SD)	Angry face (SD)	Neutral face (SD)
Anorexic group	positive	714.4(146.3)	729.1(143.6)	761.8(160.0)	700.9(122.2)
	negative	734.1(130.0)	718.1(139.1)	710.7(133.1)	723.9(117.6)
Control group	positive	677.4(100.9)	708.5(87.5)	714.2(93.1)	685.5(71.5)
	negative	737.5(81.0)	694.3(71.3)	705.8(90.5)	703.5(74.2)

Applying ANOVA repeated measures we have found **no group differences for emotional schematic faces** used as primes (F (1, 67) =0.74 p<0.37). There was a significant **interaction between primes and target valences** (F (2, 67) =12.35 p<0.00), it means that the faces expressing different emotions influences the reaction times on the responses for the target words. We computed facilitation and inhibition effect based on the method as it was described above in the procedure of the affective priming task. ANOVA revealed **no group differences for the inhibition and facilitation effects**. Figure 11 show that in the **anorexic group there was no significant difference between inhibition and facilitation for the happy face** but **there were significant differences for the sad face** (t (35)=3.12 p< 0.01) and **the angry face** (t(35)=3.28 p<0.01). In the **control group there were significant differences for the happy face** (t (35) =2.65 p<0.02) and **the sad face** (t (35) =2.24 p<0.03) but **not for the angry** face.

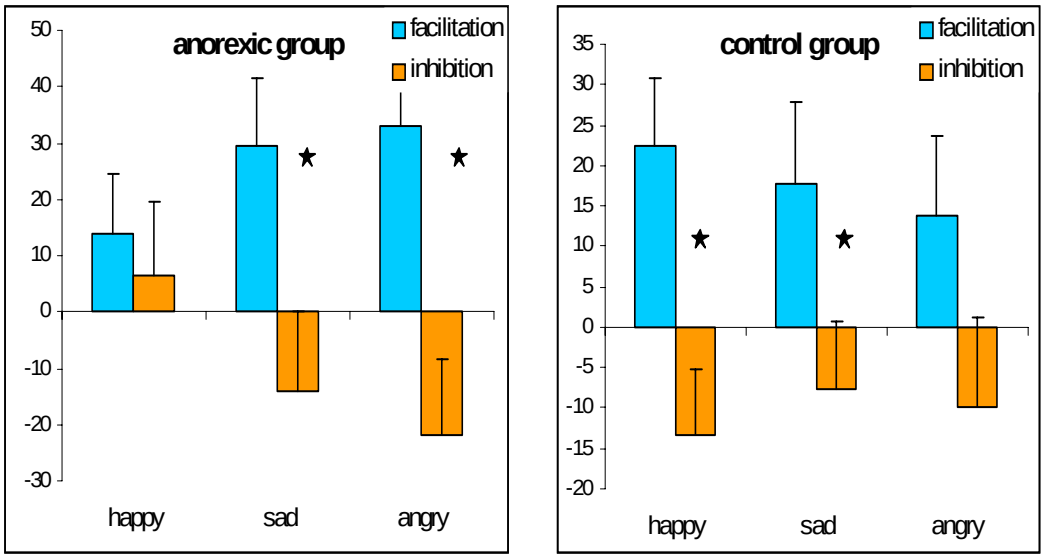


Figure 11 Facilitation and inhibition effects separated in the two groups. Asterisks indicates significant differences between the paired columns (*) =p<0.05, error bars shows SEM.

The figure 12 show the result of the overall priming effect in the two groups for the three emotional faces. T-test revealed **group difference for the happy face** (t(70)=1.86 p<0.05). It means that anorexic group treated less the happy face than the control group.

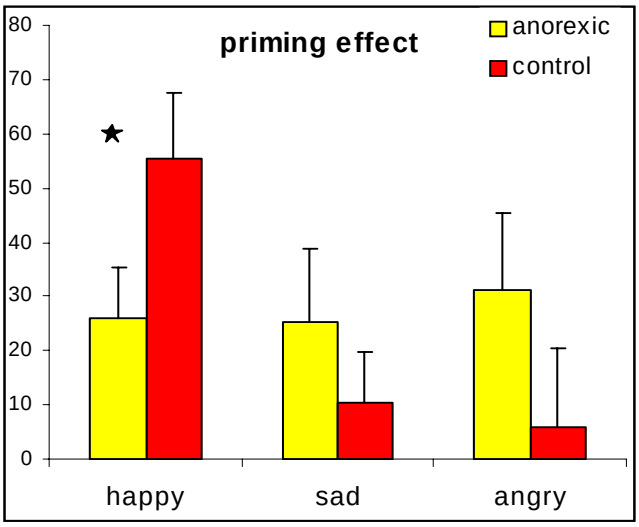


Figure 12 Priming effect for the three different emotions in the two groups. (*) p<0.05 asterisks indicates significant differences and error bars show the SEM.

10.2. Table 20 shows the relationship between psychological distress and the treatment implicit emotional information. Pearson correlation revealed **negative relationship between the speed of the treatment of the positive emotions and the psychological distress in the anorexic group.** While **psychological distress was positively linked to the treatment of the anger in the anorexic group**. In the control group no correlation was found between the implicit task and the psychological distress, which might be due to the low level of psychological distress in this group.

10.3. Table 20 shows the results of the correlation between the speed of the treatment of the emotional stimuli and the alexithymia. There were several strong correlations between alexithymia and treatment of the emotional stimuli on the implicit level in the patients group. Alexithymia had a negative relationship with negative emotions (anger, sadness) resulting an inhibition or suppression on the implicit negative emotions processing. While positive emotion (happy face) related positively to the level of alexithymia (see Table 20). We added to the correlation one of the subscale of the Eating Disorder Inventory (Interoceptive awareness) because it measures similar personality factor such as the TAS difficult identifying feelings dimension. However, Interoceptive awareness dimension correlated negatively to the treatment of the positive emotions. In the control group we did not find any correlation between the personality factors and the implicit treatment of the negative emotions. Positive emotions treatment was linked positively to the level of alexithymia. It seems that alexithymia facilitate the treatment of the positive emotional prime face in both groups.

Table 20 The correlation between the treatment of the facial emotional stimuli and the questionnaires

			
Anorexic group			
SCL90- Psychological distress	- 0.64 *	0.58*	Ns.
TAS –dif. Identify feelings	Ns.	Ns.	Ns.
TAS –dif. Describe feelings	Ns.	Ns.	-0.44
TAS- externally oriented thinking	0.50*	-0.46*	-0.53**
TAS-Alexithymia	0.43*	-0.41*	Ns.
EDI –interoceptive awareness	-0.53*	Ns.	Ns.
Control group			
SCL90- Psychological distress	Ns.	Ns.	Ns.
TAS –dif. Identify feelings	0.39*	Ns.	Ns.
TAS –dif. Describe feelings	Ns.	Ns.	Ns.
TAS- externally oriented thinking	0.36*	Ns.	Ns.
TAS-Alexithymia	0.35*	Ns.	Ns.
EDI –interoceptive awareness	Ns.	Ns.	Ns.

. TAS=Toronto Alexithymia Scale, SCL90 PSI index, EDI = Eating Disorder Inventory interoceptive awareness. (*) $p<0.05$, (**) $p<0.01$

11. Hypothesis about explicit and implicit evaluation of body figures in anorexia nervosa

11.1. AN group reported **significantly more disturbances on almost all the dimension of the eating attitudes** (EDI, $F(1, 65) = 18.11$, $p<0.00$, see Table 21). The only subscale on AN patients scored not significantly was the body dissatisfaction scale. Considering EDI total scores, 66% of the AN group and 14% of the control group showed pathological attitudes, feelings and behaviours related to food, eating and body image

Table 21 Summary of the eating disturbances in anorexic and control groups.

	Anorexia M(SD)	**Control M(SD)**	**df**	**F**	**p>**
Eating Disorder Inventory	66.2 (29.8)**	30.0 (18.0)	1.65	18.11	0.00
EDI –Drive for thinness	12.3 (6.5)*	6.2 (6.1)	1.65	7.24	0.01
EDI - Bulimia	4.1 (5.8)*	0.8 (1.7)	1.65	4.84	0.04
EDI – Body Dissatisfaction	15.5 (7.2)	9.9 (8.9)	1.65	3.50	0.07
EDI - Ineffectiveness	8.5 (5.4)**	3.6 (2.1)	1.65	11.88	0.00
EDI - Perfectionism	6.5 (4.1)**	2.9 (2.0)	1.65	10.36	0.00
EDI – Interpersonal distrust	4.8 (4.1)*	2.3 (1.9)	1.65	4.70	0.04
EDI – Interoceptive Awareness	7.9 (4.5)**	1.9 (1.8)	1.65	25.54	0.00

Asterisks indicate significant values (*) $p<0.05$, (**) $p<0.01$

Correlation revealed that depression and anxiety were not related to the body dissatisfaction in the anorexic group. However in the control group the drive for thinness dimension was linked to the level of depression ($r=0.41$, $p<0.02$) and state anxiety ($r=0.46$, $p<0.02$). Overall eating disorder problems can not be associated either with depression or anxiety in AN group.

11.2. Considering explicit attitudes toward prime body silhouettes measured on the 7 point Likert scale, the **anorexic group judged the ideal body figure to be much less positive** ($F [1, 67] =12.03$, $p<0.01$; AN: $M=4.63$, $SD\pm1.62$; control: $M=5.82$, $SD\pm1.21$), and the **overweight body figure to be much more negative** ($F [1, 67] =23.32$, $p<0.01$; AN: $M=1.16$, $SD\pm0.52$; control: $M=2.22$, $SD\pm1.24$). Both groups evaluated the **underweight body figure as neutral** ($F [1, 67] = 0.06$; $p<0.9$; AN: $M=2.90$ $SD\pm2$; control: $M=2.93$, $SD\pm1.9$) given that a mean close to 3 on the scale indicates a neutral evaluation.

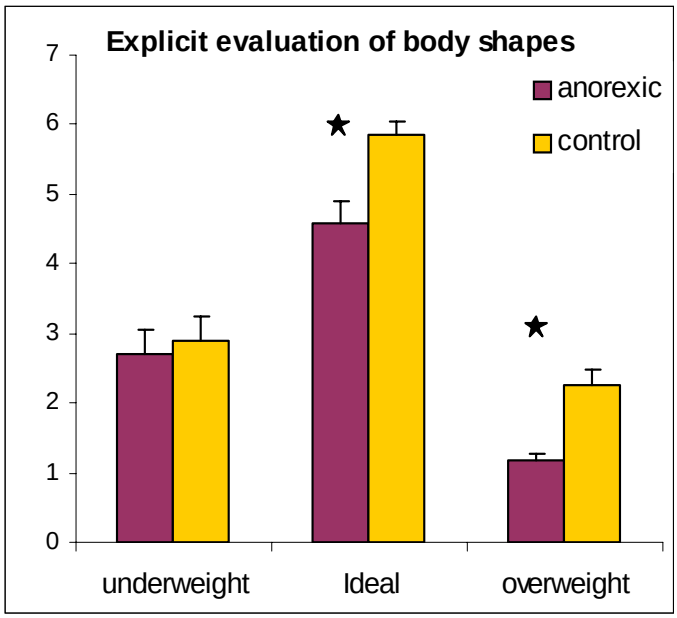


Figure 13 Evaluation of the prime figures in the anorexic and control groups. Asterisks indicate significant differences (*) $p<0.05$.

11.3. Response latencies (RL) associated with correct responses either too fast (300 ms) or too slow (1000 ms) or erroneous ones were excluded from analysis. The affective priming effects were analysed by examining the interaction between

the valence of target and prime stimuli in both groups. Our results focus on response latency (speed), as no differences were found on response accuracy (number of errors). We did not find any significant difference for groups in general response speed considering all targets (t [68] = 0.73, p< 0.47; AN: M=725 ms, SD = 135; control: M= 706 ms, SD = 77). Table 22 shows the mean reaction times for positive and negative targets separately in the AN and control groups.

Table 22 The mean reaction times for the different body figure primes in the anorexic and control groups.

	Target valence	Ideal figure	Underweight figure	Overweight figure
Anorexic group	negative	736.85 (124.98)	719.95 (142.74)	728.20 (136.22)
	positive	737.49 (163.20)	730.49 (150.76)	753.82 (165.61)
Control group	negative	724.26 (89.80)	737.32 (124.74)	737.16 (107.06)
	positive	670.80 (83.33)	694.04 (91.50)	719.60 (87.79)

A **strong interaction was found between primes and the targets within subject** (F (2, 67) =13.16; p<0.01). There was a significant difference for group x target interaction (F (1, 68) = 7.52, p<0.01). Paired t-test revealed that responses latencies for positive target were shorter than negative targets in the control group (t(33)= 38.6, p<0.01), while in the AN group no significant difference was found between the two valences.

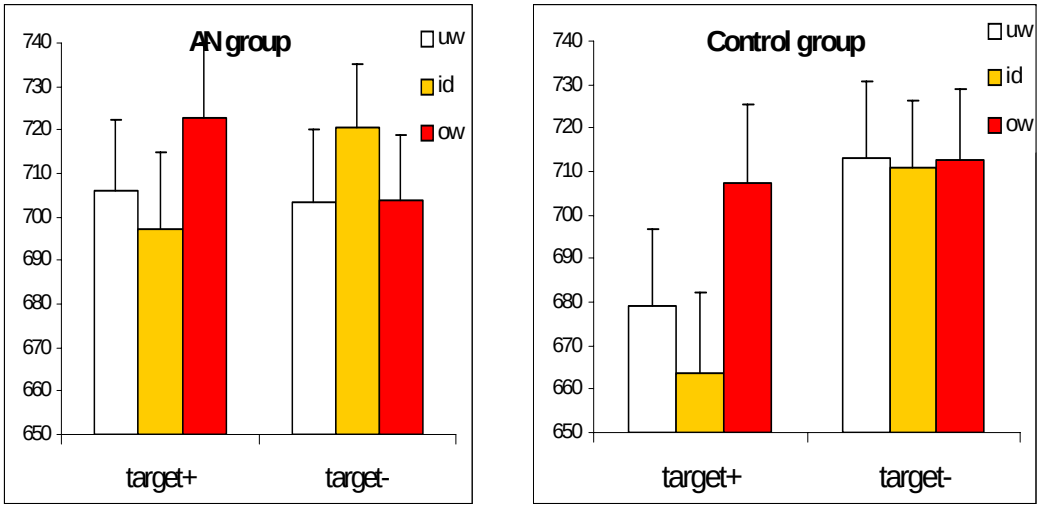


Figure 14 Mean response latencies (s) in AN and the control group on target words (+ and -) anticipated with three different body silhouettes primes. uw = underweight, id= ideal, ow= overweight figure. SEM is indicated with error bars

The priming effect was computed from the congruent and incongruent prime/target combination as it was described above in the procedures. Figure 15 shows the calculated priming effect for each silhouette in the two groups. There was a significantly larger priming effect of the **underweight body shape in the control group** than in the AN group (t [65] =2.33; p<0.03). In contrast with controls, in the AN group the priming effect for the overweight body prime was relatively large; however the difference between the two groups was not significant (t [65] =1.72; p<0.09).

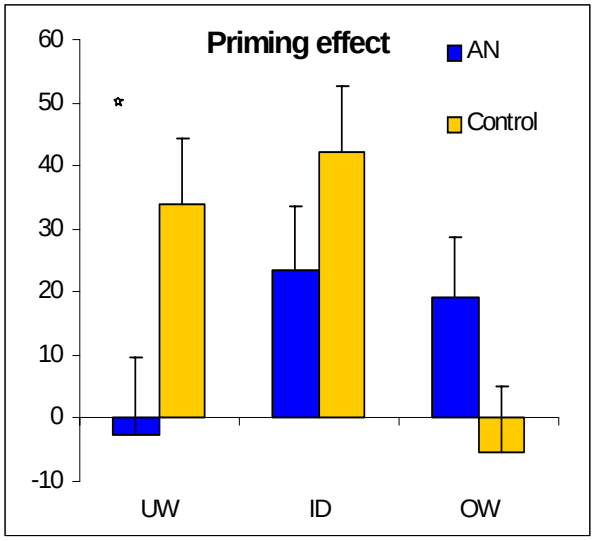


Figure 15 Priming effect for the three different body silhouettes used as a prime in the two groups. (*) p<0.05 asterisk indicates significant differences, error bars show SEM values.

11.4. Partial correlation of explicit attitudes and self-reported questionnaire revealed negative relation between the anorexic figure, EDI score (r= 572), and trait anxiety (r= 399) in anorexic group, it means that patients reporting more eating problems and anxiety had more positive explicit attitude toward very slim figure. In the control group there was no similar correlation found between questionnaire scores and the body figures. The **depression had no influence on how participants judged the figures**. Pearson's correlation was used to examine the relationship between the implicit, explicit evaluations and the other variables such as the three dimensions of the EDI questionnaires measuring

attitudes in relation with participant's own body (Drive for thinness, Bulimia, Body Dissatisfaction, see Table 23), as well as depression and anxiety separately for the two groups. We first assumed that depression and anxiety might be associated with more negative implicit and explicit body evaluations. Secondly, it was presumed that more negative attitudes towards patients' own bodies would predict positive evaluations of the underweight silhouette. No previous research has examined correlation between the implicit and explicit evaluation for body figures. Table 23 shows that the "Drive for Thinness" (DT), "Bulimia" (B), and "Body dissatisfaction" (BD) dimensions were related to the explicit evaluations in both groups. The higher the AN **group scored on these three dimensions the more positively they judged the underweight body figure** and the more negatively they judged the normal figure. DT and BD dimensions had the same effect on the explicit evaluation of the overweight body figure in the control group. Considering the implicit body evaluation in the AN group, that the DT score was positively correlated with the priming effect of the underweight figure. **Depression and anxiety contribute only to the explicit body evaluation in the control group** but not in the anorexic group.

Table 23 The relationship between explicit-implicit body evaluation and body image disturbances in anorexic and control groups.

Variable	Explicit			Implicit		
	UW	ID	OW	UW	ID	OW
AN group						
EDI Drive for Thinness	0.49*	-0.60*	0.05	0.55*	0.11	-0.35
EDI Bulimia	0.55*	-0.65**	-0.15	0.25	-0.17	0.01
EDI Body Dissatisfaction	0.24	-0.54*	-0.03	0.17	0.18	-0.33
Depression	0.02	-0.11	-0.06	0.16	-0.14	-0.13
Anxiety	0.29	0.15	0.02	0.41	-0.12	0.15
Control group						
EDI Drive for Thinness	-0.06	0.25	-0.55**	0.01	0.13	-0.08
EDI Bulimia	-0.08	0.20	-0.21	-0.09	0.42*	-0.28
EDI Body Dissatisfaction	-0.15	0.17	-0.40*	0.11	0.05	0.01
Depression	0.27	0.24	-0.35	0.21	-0.01	-0.02
Anxiety	0.19	0.03	-0.39*	0.28	-0.13	-0.05

BDI= Beck Depression Scale, STAI- State /STAI-Trait =Spielberger State Trait Anxiety Inventory, EDI =Eating Disorder Inventory, DT =Drive for thinness, B =Bulimia, BD= Body Dissatisfaction, I =Ineffectiveness, P =Perfectionism, IA =Interoceptive Awareness, (*) $p<0.05$, (**) $p<0.01$.

13.3. Can excessive eating and restrictive eating be the two sides of the same coins?

12 Hypothesis about the possible common mechanism in eating disorders

12.1. The aim of this thesis was to examine, whether there are common mechanisms in obesity and restrictive type of anorexia nervosa in order to confirm the continuum model of the eating disorders. The results of the neuropsychological tasks show **attentional deficit and distractibility** in obese children, obese adults and anorexic adolescents assessed by the D2 attention endurance test. Children with obesity performed worst on **set-switching** by committing perseverative errors. The cognitive performance of the obese adults shows similar impairments than the performance of the children suggesting **the executive dysfunctions in the statues of obesity**. The table 24 indicates also inhibition (verbal suppression) problems measured by the Hayling task. AN patients showed a tendency to fail to maintain the sets as a result of distractibility on WCST. However, our examination **did not confirm the executive function deficit hypothesis in restrictive anorexia nervosa, most importantly our results revealed relationship between anxiety and perseveration in restriction**. Based on the results of the test in the Table 24 we suggest certain brain areas involved in the different pathologies.

Table 24 Summary on the cognitive functioning in anorexia and obesity referring to the healthy control population.

Cognitive functioning	Anorexia nervosa	Obese children	Obese adult
Working memory	NS	NS	NS
Intelligence	NS	NS	NS
Attention	High distractibility	High distractibility	High distractibility
Executive function			
Verbal fluency	NS	NS	NS
WCST	Distractibility	Perseveration	---------
Trail making test	------	-------	Distractibility
Hayling test	------	-------	Inhibition problem
Suggested brain area involved	*Fronto-central*	*Prefrontal-Frontal*	*Prefrontal-Frontal*

NS =no significant difference found

12.2. It was suggested that obese and anorexic group would implicitly treat differently the negative emotions in comparison to controls with normal body weight. Figure 16 provides an overview on the inhibition and facilitation mechanism in the patients and the control groups (average of the two control groups). The values above the 0 indicate more pronounced facilitation effect, while the values below the 0 line show stronger inhibition effect on each of the three emotional faces. The figure 16 shows **different treatment of emotional information in obesity and anorexia on the positive and negative (sad, angry) faces.** The second and the third graphics (fig 16) indicate that patients with obesity did not treat the negative faces especially the sad face in the incongruent (inhibition) negative prime-positive target situations. Most probably during the task they reacted mostly for the positive target words by ignoring the negative face primes, therefore their time reaction was shorter than the control or anorexic groups. In contrary to our hypothesis, in spite of the sever depression, obesity is associated with an attentional bias toward positive cues.

In the **anorexic group we have found the opposite mechanism, patients** had the **difficulty to treat happy faces** compared to controls and obese group. The first graphic shows that the time reactions of the patients with anorexia in the incongruent situation (inhibition) were less influenced by the happy face than controls, AN patients did not treat positive face, therefore their performance was better than the one of the other two groups. The second graphic confirms that anorexic patients were more sensitive to negative emotions specially anger, because in both congruent and incongruent situations we have found more pronounced inhibition and facilitation effects in this group (see the difference between the 0 line and the calculated effects). These results suggest that restrictive anorexia nervosa is associated with enhanced vigilance for angry face and an attentional bias toward negative emotional information.

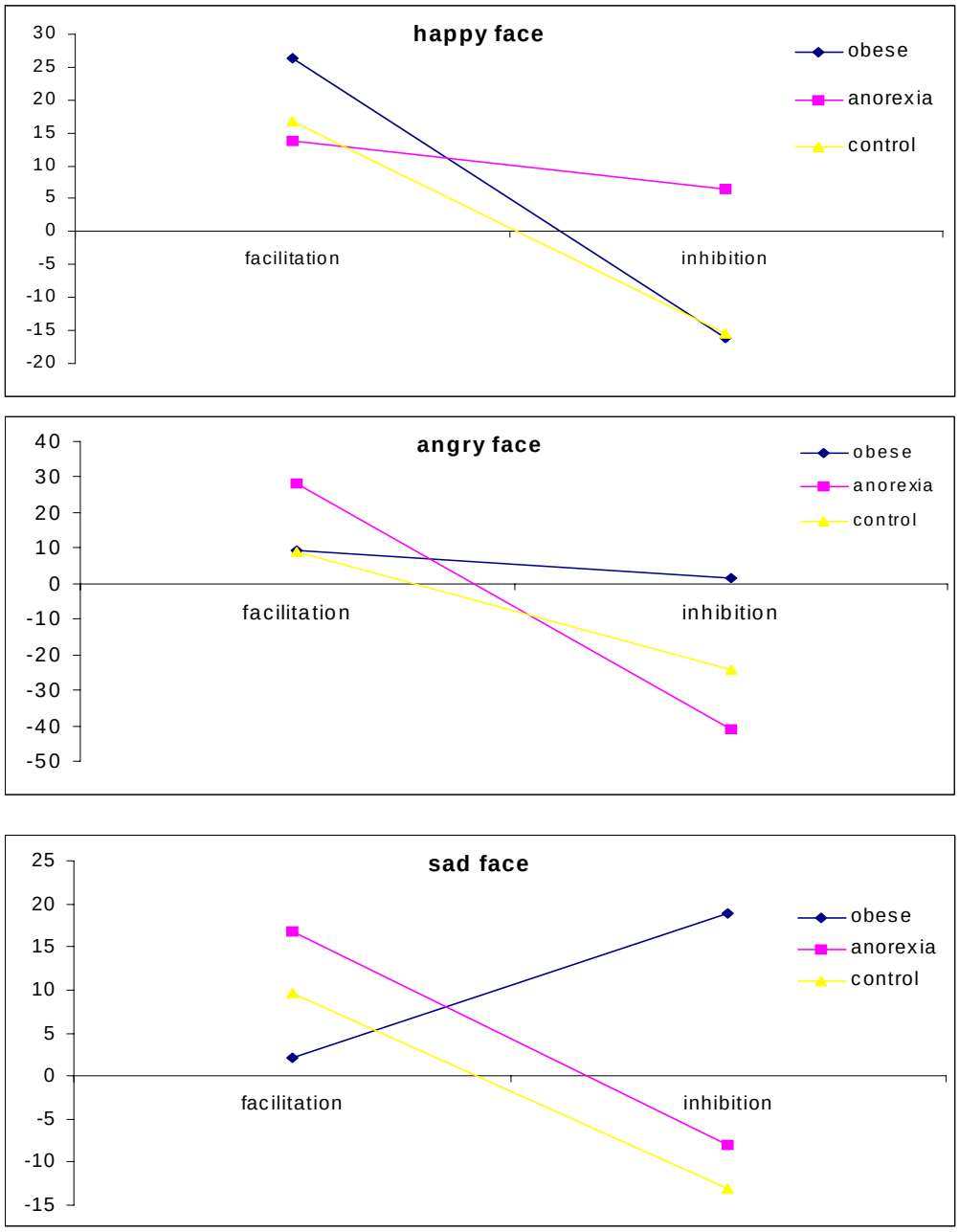


Figure 16 Summary of the implicit treatment of the emotional information in obesity, anorexic and the two control groups together.

12.3. The hypothesis about the implicit body figure evaluation in eating disorders supposed to find positive evaluation of the participants own body figure. Figure 17 show the summary on the implicit evaluation in the two patients groups (obese and anorexic) and the mean of the two control groups. The figure 17 represent the computed priming effect on the four different body silhouettes separately based on the following prediction: underweight and ideal body shape would be evaluated positively, while overweight and obese shapes negatively. The columns above the 0 line indicate the confirmation of our prediction, while the columns below the 0 line show that our prediction has not been correct. For example the third group of columns indicate that **obese group did not evaluate negatively the overweight body shape.** And the first group of column show that **the anorexic group did not evaluate positively the underweight body shape.** There was significant difference between anorexic group and the other two groups for the underweight body figure ($p<0.02$). We have found also significant difference between the obese group and the other two groups (anorexic and control) for the overweight body figures ($p<0.03$).

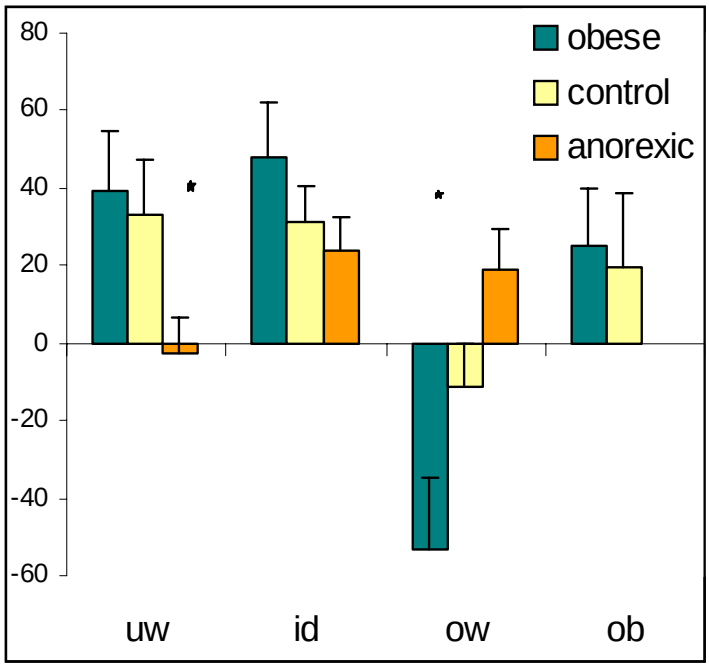


Figure 17 Summary of the implicit body figure evaluation (priming effect) in eating disorders. Uw=underweight, id=ideal, ow=overweight, ob=obese figure. Asterisk indicates significant differences.

14. Discussion

14.1. Excessive eating

Our findings concerning the hypothesis 1.1 are discussed based upon the article of Renata Cserjesi, Olivier Luminet, Denes Molnar and Laszlo Lenard: IS THERE ANY RELATIONSHIP BETWEEN OBESITY AND MENTAL FLEXIBILITY IN CHILDREN? Appetite 49(2007) 675-678.

- **Hypothesis 1.1:** It was confirmed the **executive dysfunction in childhood obesity**. The main finding of the examination is that **children with obesity performed worse on the WCST and D2 despite similar intelligence and memory capacity** to that of the control group (Cserjesi et al. 2007). In contrast to the finding of Gunstad et al. (2006), obese children did not show any memory deficit in the digit span task. As the positive correlation confirmed, perseverative responses and D2 were associated with body weight and BMI but not with memory, verbal fluency or intelligence. This outcome is in line with the hypothesis of Hernandez and Verdejo-Garcia and it supports the addictive nature of obesity. In the D2 attention test the obese children could detect fewer symbols during the 20 seconds time limit than controls what can be explained in two ways. The first one is that the attention focus of obese children is reduced compared to controls, and that is why they could detect fewer symbols within the available time. The second possible explanation would consider longer motor response and prolonged reaction time in obese children; therefore they crossed out the target symbols with the pen slower. Even in the case of the latter, changes in the attention endurance capacity could not be ruled out. Nevertheless, further investigations should be done to validate the explanations in terms of cognitive attention focus and behavioural motor answers. However, verbal flexibility and inhibition underlying PFC mechanism, was identical in both groups. Either this task was too simple and rather short (1 minute for each category) to efficiently assess verbal flexibility or we should distinguish between verbal and performance based mental flexibility in obesity. In both cases, further examination is needed to specify the possible existence of

separate verbal flexibility deficits in obesity. Our findings suggest that obesity involves perseveration and attention problems.

The **hypothesis 1.2** and **3** is discussed based upon the article of Renata Cserjési, Olivier Luminet, Anne-Sophie Poncelet, László Lénárd *: ALTERED EXECUTIVE FUNCTION IN OBESITY: EXPLORATION OF THE ROLE OF THE NEGATIVE MOOD ON COGNITIVE ABILITIES. Under revision in Appetite*

- **Hypothesis 1.2:** We were interested in whether adult obesity can be characterized by any specific deficit of the executive functions. When addressing the first question on the existence of possible deficits in the different executive functions the overall answer is that **attentional distractibility and mental inflexibility due to altered suppressing (inhibition) is associated with adult obesity.** Despite similar education level and social status women with obesity performed significantly worst on D2 attention endurance test and all the three parts of the Hayling task. These findings are in line with the results of our previous examination (Cserjesi et al., 2007) with 12-year-old obese children who showed more perseveration during solving Wisconsin Card Sorting Test than peers with normal body weight. Braet et al. (2007) have found also lack of cognitive control and disinhibition (impulsivity) in children with obesity supporting the idea of executive function deficit in obesity. However, other neuropsychological tasks measuring executive functions did not show any differences between the two groups in the present study suggesting the existence of other factors having an impact on the performance of neuropsychological tasks.

- **Hypothesis 2:** As we predicted in ***hypothesis 2.1***, we have found **more depression** assessed by two different questionnaires (BDI and SCL90-R) in the obese group. The ***hypothesis 2.2*** was confirmed also because **depression was related to the severity of the obesity.** Together with depression we have found increased level of psychological distress and state anxiety associated with obesity state as it was previewed in the ***hypothesis 2.3***. However, trait anxiety and negative affectivity was not associated to obesity.

- **Hypothesis 3:** To confirm this hypothesis we investigated the relationship between negative-positive affectivity, anxiety, depression and the cognitive performance. In contrary to the results of Holmes and Pizzagalli (2007) we have found no evidence for the influence of the depression on the executive functioning. What we have found is that **positive affectivity had a correlation with most of the neuropsychological tasks** (e.g. verbal fluency, D2 attention test, digit span backward and TMT). To date, many clinical studies were focusing mostly on the impact of the depression (Weiland-Fiedler et al., 2004) on the cognition; our finding propose a different point of view in this question, notably the importance of the facilitating role of positive emotional state in executive functions. The performance on the Hayling task was not affected by emotional state; it seems that this task measures mental flexibility independently from mood.

- **Hypothesis 4:** In contrary to our prediction in the ***hypothesis 4.1*** the **severity of alexithymia could not be associated with obesity.** The obese group showed significantly more difficulty identifying feelings assessed by the first subscale of the TAS20, but this problematic emotion recognition was due to depressive status of the obese patients as it was presumed in the ***hypothesis 4.2.*** Pinaquy et al. (2003) reported a strong correlation between alexithymia and emotional eating in obesity linked to BED (binge eating disorders). Our results suggest that overeating induced obesity is not necessarily linked to BED and the obese participants in our study more likely belonged to stabile obese category without BED. Apart from depression and state anxiety the affectivity of the obese group was similar to the control group.

- **Hypothesis 5:** We confirmed the **hypothesis 5.1** that **obese patients treat facial negative emotions differently than control** non-obese people. The computed facilitation and inhibition effect showed that obese people in the inhibition situation did not treat the sad face at all they reacted mostly to the positive target words. But they treated faster the happy face both in the inhibition and facilitation situations. These findings suggest that **obese patients are more prone to treat or allocate their early attention toward positive stimuli** than control participants. It can suggest that people with obesity are

rather sensitive to positive feelings and they are more sensitive to rewarding situation than control. Despite significantly higher depression in the obese group they are focusing on the happy face and ignoring the negative emotions (like sadness or anger). In contrary to our ***hypothesis 5.2*** **psychological distress** measured by the three indexes of the SCL90-R questionnaire **did not contribute to the speed** of the treatment of the emotions. However, ***hypothesis 5.3*** was confirmed because of the alexithymia influenced the general treatment speed of the primes and independently from the depression it contributed positively to the facilitation effect of the negative emotions. These results confirms the finding of Vermeulen et al. (2006) that **alexithymia influence the implicit emotional information processing independently from depression or negative mood**.

- **Hypothesis 6:** In the hypothesis 6 we were interested about the perception and explicit-implicit evaluation of the body image in obesity. In contrary to the ***hypothesis 6.1*** we found out that **patients with obesity** not overestimate but consequently **underestimate their own body figure** on the body figure scale. Furthermore our results revealed that this **misperception was due only to the severity of the depression in the obese group**. In contrary to our ***hypothesis 6.2*** obese participants selected the same body figures as ideal from the body figure scale than control. They considered **explicitly the same body shape as beautiful as control participants.** Correlation revealed that the bigger was the distance between the ideal body figure selected and the reel body shape on body figure scale the higher depression was reported by the participants. This finding suggests that the **depression in obesity might due to the increasing social pressure** on slim appearance. As we predicted in the ***hypothesis 6.3*** the obese participants ranked higher on most of the subscales of the Eating Disorder Inventory than controls with normal body weight. Obese patients reported higher disturbance on body dissatisfaction and more drive for thinness than control. ***Hypothesis 6.4.*** However, in contrast to the explicit self-evaluation, **obese participants implicitly evaluated more positive body images even overweight** or **obese figure** than controls. The findings indicate a strong discrepancy between the self-presentation of the obese participants and their implicit preferences. Our results suggest that obese patients implicitly evaluated

fatness more positively than control people, which means that implicitly they accept more their own outfit and body figures. However, explicitly obese people judge the body shapes similarly as control participants. This difference between explicit versus implicit evaluation might cause the relapse of the diets or the yo-yo diets in obesity. However, to prove the role of the explicit vs. implicit evaluation in the phenomena of the yo-yo diet and the relapses of the diets further researches should be carried out. Given the fact that obese people implicitly evaluate feminine body as positive, we propose that depression in obesity can be a reaction for the overwhelming social expectation regarding sliminess and ideal appearance.

14.2. Restrictive eating

- **Hypothesis 7**: In contrary to our ***hypothesis 7*** and the previous findings no deficit was found on the set-shifting capacity measured by WCST in the AN group. However, they showed a tendency to fail set-maintenance, which means to retain the current sorting rules in mind through varying stimulus conditions, while ignoring irrelevant aspect of the stimuli (Huizinga & van der Molen, 2006). The set-maintenance process is indexed by distraction errors, involving random failures to maintain set and distraction errors occur when the sorting rule is missed continuously. Our results revealed a tendency in the AN group on set-maintenance abilities, which is considered as a result of distractibility. Barceló (32) reported data from an event-related-potential (ERP) study in normal adults, showing that errors reflecting set-switching abilities were associated with the activation of a frontal-extrastriatal network, whereas **set-maintenance abilities were associated with frontal-central activation linked rather to the attentional circuit.** Confirming the **distraction problems** significantly worse performance was found on the D2 attention endurance test in the AN group.

- **Hypothesis 8** was based on the question concerning the relationship between negative mood, anxiety and neuropsychological tasks. Our results showed that the performance on **D2 and WCST are influenced by the level of anxiety** in the anorexic group. The results revealed that **perseveration in the AN group depended only on the severity of anxiety but not on depression**. Kaye et al. (2006) suggested that anxiety disorder appears in childhood and that it occurs before the onset of anorexia nervosa. This is consistent with the notion that **anxiety is a vulnerability factor for developing anorexia nervosa** later on in life. Despite previous findings supporting the role of perseveration and executive function deficit in anorexia nervosa these deficits might be interpreted in terms of the consequence of anxiety disorder. In addition to similar performance on the WSC test, only the BMI of the control women correlated positively with perseveration. This suggests that increased BMI can be associated with perseveration. This finding confirms the result of our previous study (see first examination above with obese children) which showed more perseveration and mental inflexibility (as measured by the WSCT) in obese children compared to normal body weight peers.

- **Hypothesis 9:** ***hypothesis 9.1*** suggested that **anorexia nervosa is associated with alexithymia.** Our results confirmed that anorexic patients scored significantly higher on alexithymia and each subscale of the TAS20. However, as it was predicted in the ***hypothesis 9.2*** depression was correlated with alexithymia, which suggest that **alexithymia in anorexia is due to the depressive status.** Further investigation should be done to measure the changing in the level of the alexithymia in anorexia nervosa after the treatment of depression and anxiety and/or after regaining the patients' normal weight.

- **Hypothesis 10:** in the ***hypothesis 10.1*** we proposed that the treatment of the negative emotions on the implicit level is different in the anorexia nervosa than in the control group. In contrary to our prediction there was no difference between anorexic and control group for the treatment of negative emotions. But we have found significant difference for the implicit treatment of the positive emotions. Our results revealed that **anorexic patients do not treat the happy face in the incongruent situation** (happy face combined with negative target

words); they react on the negative target values. It suggests that AN patients allocate their early attention rather toward the negative stimuli, which might represent a threat to them. Similar patterns have been found in anxiety disorders, where the direction of the patients' attention was driven by the perceived dangerous cues in the environments. This finding is in line with the hypothesis that anxiety might be a vulnerability factor in the development of the anorexia nervosa. As it was suggested in the ***hypothesis 10.2*** we have found negative correlation between the psychological distress and the treatment of the happy face, and a positive correlation between the distress and the treatment of the negative emotion (anger) in the anorexic group. **Alexithymia had a moderating effect on the treatment of the facial emotion on the implicit level** as it was predicted in the ***hypothesis 10.3.*** Surprisingly, **alexithymia in the anorexic group related positively to the treatment speed of the positive emotions** while it had a negative effect on the treatment of the negative emotions. These findings suggest that **alexithymia might have a protective role in the emotional treatment in stress situation.**

- **Hypothesis 11:** we were interested in the evaluation of body image and the attitudes toward body in anorexia first. Our results are discussed based upon the article of *Renáta Cserjési, Nicolas Vermeulen, Olivier Luminet, Clarisse Marechal, François Nef, Yves Simon, László Lénárd:* EXPLICIT VERSUS IMPLICIT BODY IMAGE EVALUATION IN RESTRICTIVE ANOREXIA NERVOSA. Under revision in Psychiatry Research

  Hypothesis 11. 1. In line with the previous findings the anorexic group reported more body dissatisfaction and more drive to thinness despite their starvation and dangerous underweight. But surprisingly, in the **anorexic group body dissatisfaction was not related to the severity of the depression or anxiety**. Only in the control group there was a positive relationship between depression and body dissatisfaction. Moreover anorexic group judged explicitly less positive the ideal body figure and more negative the overweight body figure than controls. In contrary to our ***hypothesis 11.2*** **anorexic girls did not evaluate more attractive the underweight body figure** than the controls.

  Hypothesis 11.3. We were interested in how implicit and explicit evaluations of body shapes relate to each other in AN. Another implicit measure, the Implicit

Association Test (IAT) was used in the study of Schwartz et al. (2006) to assess attitudes towards participants' own bodies in healthy individuals. They found that healthy thin people were more likely to automatically associate negative attributes with fatness. When addressing our question of whether there are differences in explicit and implicit evaluations between women with restrictive AN and participants of healthy weight, our overall findings support a difference with respect to both explicit and implicit evaluations. On the explicit measures, women with **AN evaluated the normal and overweight body shapes more negatively than the control** group. This finding is in line with those of previous studies (Cooper and Turner, 2000; Vartanian et al., 2005) which found more negative attitudes toward fatness in women with AN, compared to dieters or non-restrictive eaters. There was no general group difference for implicit evaluations in the priming task. Yet, both groups showed a preference towards normal body silhouettes. However our results revealed that the AN group implicitly evaluated overweight body figure as negative, while the control group implicitly evaluated the underweight body as positive. This finding is consistent with those of the IAT study (Schwartz et al., 2006), that underweight women attributed a more negative value to fatness. Gawronski et al. (2007) proposed that implicit and explicit evaluations differ on the grounds that implicit evaluations were the outcome of activation of associations mostly from memory, while explicit evaluations reflect the result of a validation process. In contrary to the control group, a very small priming effect for underweight silhouettes in the AN group indicates that **underweight body image did not activate positive associations in the AN group**. Buree et al. (1984) have found that a thin body ideal might not be as critical to AN as it has previously been assumed. Our findings based on the implicit and the explicit evaluations of the underweight silhouettes confirmed that **underweight body shape preference is not the key element in restrictive AN**. ***Hypothesis 11.4*** we examined the role of mood and various dimensions of body image attitudes in body evaluations. It was confirmed The "Drive for thinness" and "Body dissatisfaction" dimensions of the EDI are correlated negatively with normal body figure in the AN group and with the overweight body figure in the control group. The desire for losing weight appears to be an important motivation in both groups; indeed, only the reference body shape was different. In other words, it seems that AN patients

would like to be slimmer than the normal body silhouette, while control participants would like to lose weight (in reference to the overweight silhouette). These results raise other questions considering weight regulation in women. Further investigation should be carry out on the psychological causes of body weight regulation in order to identify the key elements which can be responsible for the maintenance of the underweight in anorexia nervosa.

14.3. Can excessive eating and restrictive eating be the two sides of the same coins?

12.1. Regarding cognitive functioning we have found that only the **attentional problem caused distractibility was a common dysfunction** in obesity and anorexia nervosa. Crone at al. (2006) observed distinct developmental trajectories for set-switching and set-maintenance abilities in the WSCT. More specifically, set-switching abilities developed during childhood and reached adult levels of performance at age 12, whereas set-maintenance abilities continued to develop into adolescence. Based on this developmental theory, it should be noted that children with obesity are probably less matured on shifting abilities than their healthy peers and the adolescents with restrictive AN show a tendency on the set-maintenance.

- One aspect is based on the increasing findings on the different brain neurotransmitter mechanisms underlying the normal and pathological eating behaviours. These theories are focusing mostly on the mechanism of the brain monoamine systems (dopamine, noradrenaline). PET study (Wang et al., 2001) has proven the involvement of brain dopamine (DA) in normal and pathological food intake in humans. Reductions in the striatum D2 receptor availability have been found in pathologically obese subjects. Neuropsychological studies (Goldman-Rakic, 1995; Damasio, 1996) reported that the prefrontal cortex (PFC) together with its subcortical connections are involved in different cognitive processes like attention,

temporal and spatial planning of behavioural patterns, shifting, as well as in emotion and motivation. These results suggest the important role of DA signals in the appetitive function. Catechol-O-methyltransferase (COMT) is a postsynaptic enzyme that metabolises the released DA mostly in the PFC where DA transporters are expressed at low levels. Human COMT is polymorphic and one of its genetic pholymorphism is associated with prefrontal DA activity which plays an important role in human cognition (Malhorta et al., 2002). Egan et al.(2001) have found that COMT polymorphism was related to performance on the Wisconsin card sorting test (WCST) of set-shifting and explained 4% of variance in frequency of perseverative errors. In addition a wide range of cognitive impairments were observed in patients with Parkinson's disease showing a close parallel between the performance of these patients and those following damage to prefrontal cortex (Gotham et al., 1988). Parkinson's disease is associated with lack of dopamine turnover, which is supporting the view that changes in the levels of dopamine stimulation may alter performance on classical prefrontal test like WCST. These findings suggest that sub-optimal performance on the tests assessing the prefrontal cortex based executive function can be associated with modified brain dopamine turnover in the PFC area in obesity. These results raise other questions considering weight problems and brain dopamine. Could it be that altered dopamine turnover is due to the COMT or other genetic polymorphism, therefore the cognitive dysfunction in eating disorders has a massive biological background? Or whether pathological behaviours for example excessive food intake would modify the working mechanism of the dopamine system?

- Other aspect focuses on rather the question of the human motivation and reinforcing behaviours. Eating is a highly motivated and reinforced behaviour that not only provides nutrients needed for survival, but also induces feelings of gratification and pleasure (Sigal, & Adler, 1976). Besides higher reward sensitivity, immediate rewards were chosen significantly more often by obese children than non-obese peers when it related to food (Davis et al., 2004). In his Reinforcement Sensitivity Theory of personality, Gray (1987) described two main systems, the Behavioural

Approach System (BAS) and the Behavioural Inhibition System (BIS). The BAS is sensitive to appetitive stimuli and activates approaching behaviours in response to cues for reward or non-punishment. The BIS is sensitive to aversive stimuli, signals of punishment and the omission/termination of reward. It leads to behavioural inhibition, increased arousal, anxiety, and heightened information processing (Corr, 2002) Physiologically, the mesolimbic dopamine system projecting to the nucleus accumbens and the prefrontal cortex (PFC) is said to play an essential role in the functioning of the BAS (Nicola at al., 2005). While BIS is associated with the septohippocampal system and the input to this system comes from the PFC (Gray, 1987). The cognitive role of BIS is to compare the current state of the world with expectations, and to inhibit and modify behaviour that leads to deviations from expectation (Revelle, 1995). Flexible goal-directed behaviour requires adaptive cognitive control by which human performance is optimised in different environmental challenges (Ridderinkhof et al., 2004). Reward/non punishment or punishment/omission of reward is used to regulate behaviour. Gray's Reinforcement Theory (1987) is in line with our finding in such a way that obese patients showed less effective cognitive control. Their difficulties to inhibit and modify current behaviour and attention distractibility demonstrated lower BIS activation. There is increasing evidence suggesting that the perceptual-cognitive experiences of people with juvenile onset obesity may differ from those of people without eating disorders (Bell et al., 1986). Davis et al. (2004) showed higher sensitivity to reward in overweighed and obese adult women that support Gray's idea about BAS function. Dopamine level in PFC and its subcortical connection promotes the sensitivity to reward, which contributes to goal oriented behaviours. Our results suggest that obesity can be associated with the higher sensitivity reward and inhibition problem because of cognitive function in obesity was linked to positive or rewarding feelings. These finding is reinforcing the hypothesis of Hernandez and Verdejo-Garcia and supports the addictive nature of obesity. While in anorexia it seems that anxiety caused perseveration reflects rather on the higher BIS activation which is driven by the fear of punishment. Trait anxiety, perfectionism manifesting in the persistence with habitude and a staunch resistance to

change (Vitousek et al. 1998) are considered to represent parts of one underlying construct that drives anorexic behaviour.

12.2. The hypothesis about the **similar dysfunction in the treatment of the negative emotions in obesity and anorexia nervosa was not confirmed** either. Our results revealed that obese patients had the problem to treat negative emotions specifically the sadness, while anorexic patients had a problem to treat the positive emotions like happiness. Our findings proved that obese patients are more sensitive to the positive emotions and the same time they ignore the negative emotions. This result suggests higher BAS activation and the role of the reward sensitivity in obesity as it was described in the previous point (12.1). It seems that obese patents are prone to seek for positive rewarding situations, while they ignore the negative cues or the future negative consequences of their behaviours. Most probably they have a difficulty to recognise the negative or punishing environmental cues the same way they did with the negative faces in our affective priming task. These negative cues could serve as a feedback or as an external control helping to regulate and adjust their behaviours in a flexible way. As eating behaviour is not just physiological need but also emotional-cognitive processes based choice, obese people would make choice based on mostly its rewarding values. In contrary to the obese patients, anorexic patients are more sensitive to negative emotions specifically those one which represent possible threats such as anger. Our results showed that psychological distress influenced positively the sensitivity to negative emotions. Enhanced vigilance for angry face was found in patients with social phobia and anxiety disorder (Mogg et al. 2004). Based on our result on cognitive and emotional functioning in restrictive anorexia nervosa, we suggest that anorexia have more common mechanism with the anxiety disorders, and anxiety can be a vulnerability factor or even the core problem in the anorexia nervosa. Previous studies have found that patients with anorexia nervosa have a difficulty to recognize facial expression and they also inhibit the negative (anger) emotion expression (Bruch, 1962; Geller et al., 2000; Kucharska-Pietura et al. 2004), however we have found a higher sensitivity to angry face and the very early treatment of the anger in anorexia nervosa. Our results show that alexithymia influenced negatively the treatment speed of the angry faces in anorexia and most probably there is also

correlation between anorexia and emotion expression as alexithymia refers to the difficulty expressing emotion. Based on the idea of Hendryx et al (1991), we suggest that alexithymia can be a strategy or a coping style to reduce and control the sensitivity to anger in anorexia nervosa.

12.3. The last hypothesis was focused on the body shape evaluation explicit vs. implicit in obesity and anorexia nervosa. We have found **different mechanisms in the two pathologies.** The explicit evaluation of body shapes in the obese group and the control group was identical. The distortions of the body figure recognition on the body figure scale in the obese group suggest that obese people have a need to fulfil the environmental expectations. While patients with anorexia nervosa judged the normal and overweight body figures differently from the control people. Regarding implicit evaluation there was a different between obese, anorexic and control groups. Obese patients evaluated implicitly more positive the overweight body figures than controls. Implicit measures are used to assess someone's evaluation or preference toward an object independently from the possible influence of the social expectation and the subject's own desire to fit for the environmental exigencies. It seems that independently from the social pressure on the slim ideal obese patients would prefer the overweight feminine type of body shape. However, fat phobia presents in anorexia nervosa even in the implicit body figure evaluations in comparison to control participants. According to the theory of Vartanian (2005) patients with anorexia nervosa are internalized the societal standards concerning slim type of body shape and the importance of the physical appearance, therefore both explicit and implicit evaluations of the overweight body figure are more negative than those of the control participants. This fact could explain why patients with anorexia are blind to the drawbacks of their underweight status and they are not aware of the future consequences of the diseases. Therefore, patients generally refuse the collaboration with their doctors or even with their families. In contrary to the anorexic patients, most probably obese patients have a problem internalizing the social standards and exigencies concerning slim beauty ideal and the physical appearance as the unique source of the social success. But at the same time explicitly they can't copy with them either which is the cause of their depression status.

Part V Conclusion

15. General discussion

The main goal of the dissertation is to investigate the common mechanisms underlying the status of the two extreme sides of the eating disorders continuum: the restrictive anorexia nervosa and the stabile obesity. Our examinations were focusing on the three key problems and the most important questions in the pathology of the eating disorders: *Cognitive functioning*

Emotional functioning

Body figure evaluation

In order to answer these questions we have used such a research tools, which are rather innovative and not yet fully introduced in the classical researches of the eating disorders. To date no implicit task using body figures as a prime was conducted with obese patients. It is the first time when the implicit evaluations of the body figures were measured with affective priming in obesity and anorexia nervosa. Until now treatments of the negative and positive emotions were measured mostly with questionnaires and cognitive tasks based on the time reaction of the negative-positive words associations (such as Stroop task). These cognitive tasks were administered mostly with patients having the classical eating disorders (anorexia nervosa and bulimia nervosa) but not with obese patients. Up until this point only a few studies have investigated other variables (e.g. personality factors, mood) that can potentially moderate the relationship between eating disorders and cognitive functioning.

Our overall findings suggest that **anorexia nervosa and obesity are not the two sides of the same coin,** but rather they can be considered as two different pathologies with a few similar mechanisms. Obesity seems to be more similar to the addictions (alcohol or drug) where food represents a natural drug. Our results confirmed that prefrontal cortex based executive dysfunction presents in obese children and obese adults similarly to patients suffering from drug or alcohol dependency. Food addiction was confirmed in obesity by the higher sensitivity to positive emotions (happy face) and the problem to treat the negative emotions (sad

face). The higher sensitivity to reward (immediate reward preference such as food intake, not considering future negative consequences) and lower sensitivity to punishment (negative emotions) are suggesting the addictive nature of obesity. Our results revealed also that severity of depression in obesity is reaction to the environmental expectation and social pressures concerning physical appearance and rewards. Most probably obese patients have a problem to internalizing the social exigencies especially when it does not promote immediate reward but rather long term success (slim body sacrifices, food restriction, body exercises).

In contrary to obesity in anorexia nervosa we have found high distractibility and early attention allocation toward negative or threatening cues. Our results suggest that anorexia nervosa have more common dysfunction with anxiety disorders. This finding support the idea of Kaye et al. suggesting that the anxiety as the most probable vulnerability factor of the development and maintenance of the anorexia nervosa.

Limitation of the studies

1. In the introduction we described that two types of subgroups can be distinguished in obesity. First is the obesity with binge eating disorders (BED) and other one is the obesity without BED. The first limitation of our studies is that we did not assess the adult obese participants on the characteristic of BED. Either we could recruit more uniform obese group (either obese patients with BED or without BED) or we could add BED as an extra variable to our data in the studies.
2. Second, that in the frame of this research we had no opportunity to use clinical population suffering from other type of psychiatric problems than eating disorder as a control. In order to specify the dysfunction related to eating disorders only another psychiatric disorder should have been helpful as a control (i.e. major depression, affective disorder).
3. Third, we did not have the possibility to collect more personal information about the patients such as the onset of the pathology, the duration of the eating disorder, and the number of relapses. We could not examine specific life events, family or personal histories, different motivational backgrounds,

which might provide complementary data for better interpretation of our findings.

Proposed treatment and research direction in the future

The current clinical treatments of the eating disorders included the anorexia nervosa and the obesity are mostly focusing on the external control of the behaviour (quality and quantity of the food consumed, weight loss or gain) of these patients. Our results revealed complex characteristics involving cognitive functions, emotions and body image which are associated with the pathology of the eating disorders. Based on our results we propose that emotional (alexithymia, reward and punishment sensitivity in emotion processing) and cognitive (attention, cognitive control) processes together play a role in the development of eating disorders and manifesting in the body weight disturbances. In the future it would be useful to investigate and develop such a complex treatment, which takes into account primary the cognitive and emotional processes together.

- **In the treatment of the obesity** it should probably be integrated the problem of the cognitive control and the treatment of the negative emotions. It would be necessary to improve obese people internal control and the sensitisation of negative feelings which might be linked to punishment. Other important component could be to bring into surface the implicit positive evaluation of the feminine body shape in obese patients and help them to realise a healthy body image together with a self acceptance. Decreasing the differences between implicit (internal preference) and explicit (social pressure) body evaluation could help to treat the sever depression in obesity too.
- **In the treatment of the anorexia** it would be useful to focus on the high need of cognitive control by reducing the anxiety (for example using techniques such as relaxation, imagination, yoga, meditation). It could be important to drive anorexic patients toward positive feelings and improve their sensitivity to reward. We suggest that negative evaluation on body shapes and high body dissatisfaction are associated with the lack of the treatment of positive situation and over-focusing on negative (specifically hostile) situation

16. References

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17. List of Publication

Articles related to the thesis:

- Cserjési R, Luminet O, Molnár D, Lénárd L (2007). Is there any relationship between obesity and mental flexibility in children? Appetite 49 675-678. IF: 1.7
- Cserjési R, Luminet O, Lénárd L. (2007). Reliability and factor validity of the Hungarian translation of the Toronto Alexithymia Scale in Undergraduate student samples. Magyar Pszichológiai Szemle 62/3.
- Cserjési R, Luminet O, Poncelet AS, Lénárd L. Altered Executive Function in Obesity: Exploration of the role of the negative mood on cognitive abilities. *Under revision in Appetite* IF:1.7
- Cserjési R, Luminet O, Vermeulen N, Maréchal C, Nef F, Simon Y, Lénárd L. Explicit Versus Implicit Body Image Evaluations in Anorexia Nervosa. U*nder revision in Psychiatry Research* IF:2.3
- Cserjési R, Lénárd L, Luminet O. Executive functioning and egocentric mental rotation in Anorexia Nervosa. Do negative attitudes and mood moderate cognitive capacities? *Submitted*
- Cserjési R, Luminet O, Vermeulen N, Poncelet AS, Lénárd L. Do obese females really want to lose weight? Explicit and implicit attitudes towards body shape in obesity. *To be submitted*
- Cserjési R, Vermeulen N, Luminet O, Maréchal C, Nef F, Simon Y, Lénárd L. Alexithymia and the treatment of facial emotional stimuli in Eating Disorders. *To be submitted*

Proceedings related to the thesis:

.

- Cserjési R, Poncelet A-S, Vermeulen N, Lénárd L, Luminet O.: The differences between implicit and explicit attitudes toward body shape in Obesity. Neurotrain summer school (FENS), Ofir, Portugal, p.: 24, 2007.
- Cserjési R, Lénárd L, Luminet O. (2007). Relationship between emotional instability and cognitive rigidity in anorexia nervosa. XVIII. MPT (Hungarian Psychiatric Association), Miskolc, Hungary.
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Other manuscripts

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18. Appendices

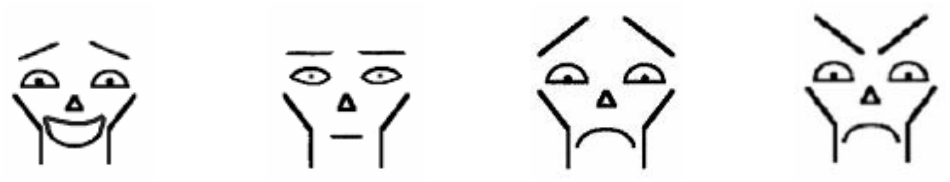
Appendix 1. Target words used in the Affective priming task (Translated form French)

Positive target	Negative targets
Delighted	Furious
Happy	Scared
Exalted	Depressed
Smiley	Sorrowful
Jolly	Demoralized
Euphoric	Plaintive
Enchanted	Hostile
Charmed	Panicked
Joyful	Irascible
Fascinated	Distressed
Satisfied	Anxious
Passionate	Stricken

Appendix 2. Target words used in the Extrinsic Affective Simon Task (EAST) (Translated from French)

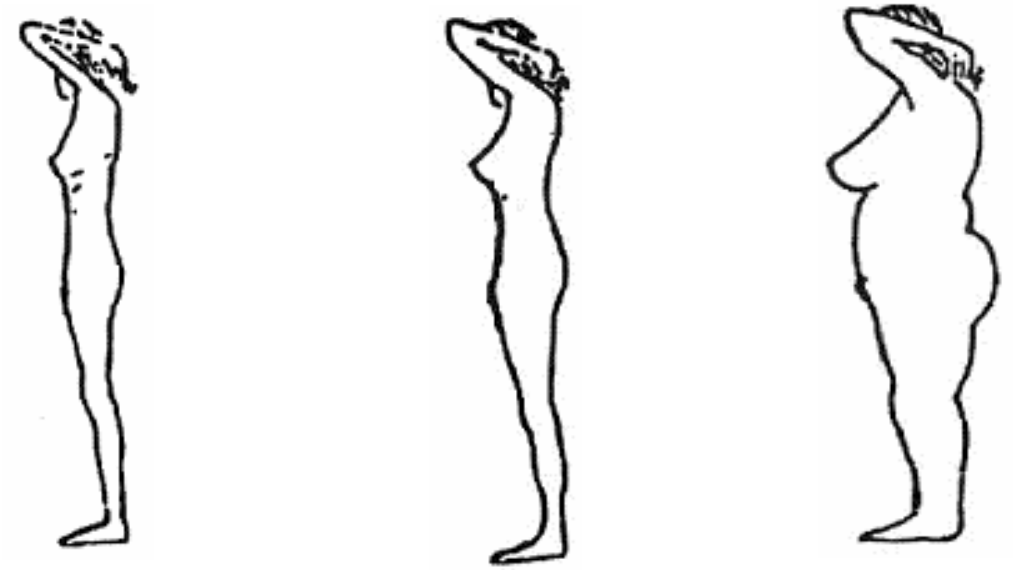
Black targets		Coloured targets	
Positive	Negative	Adipose body part	Light body part
gaiety	abandon	thigh	nose
happiness	suicide	belly	ear
joy	massacre	hip	hand
beauty	crime		
smile	pain		
peace	failure		

Appendix 3. Faces expressing emotions for affective priming task



Happy **Neutral** **Sad** **Angry**

Appendix 4. Affective priming task prime stimuli used to measure implicit attitude toward body figures in Anorexia Nervosa



Underweight body figure

Ideal body figures

Overweight body figure

Appendix 5. Affective priming tasks prime stimuli used in the examination of patient with obesity.

Underweight body figure | Ideal body figures | Overweight body figure | Obese body figure

Appendix 6. D2 attention endurance test.

Test d 2

Date : ____________ N° : ____________

Nom : ____________ Prénom : C. M ____________

Profession : ____________ Age : ____________

Exemple : d d d

Essai :

d	p	d	d	d	d	p	d	d	p	d	d	d	d	p	p	d	d	d	p	d	d
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

	RW	%	PR	SW
GZ		–		
F				–
GZ – F		–		
SB		–		–
Répartition des fautes				

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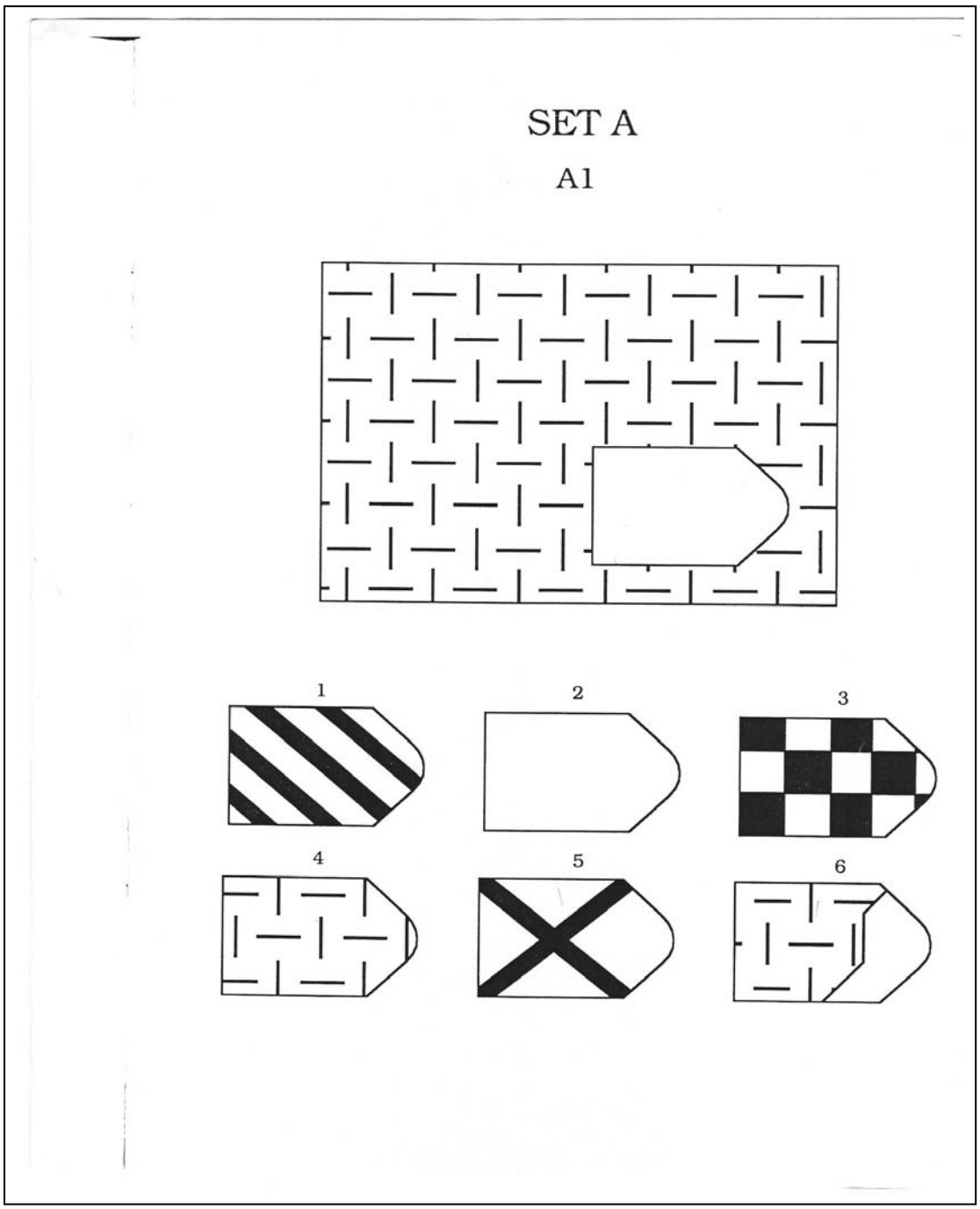
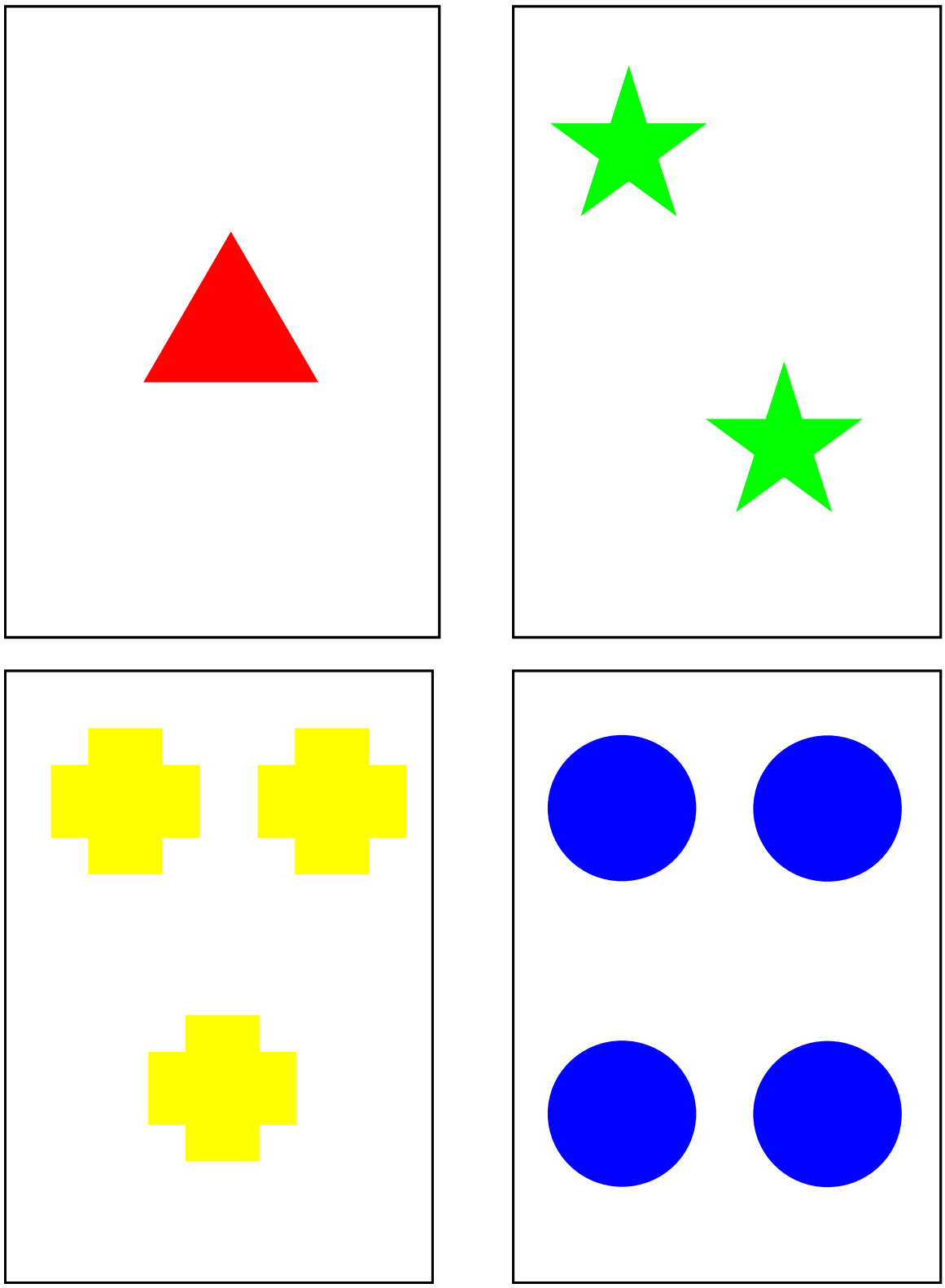
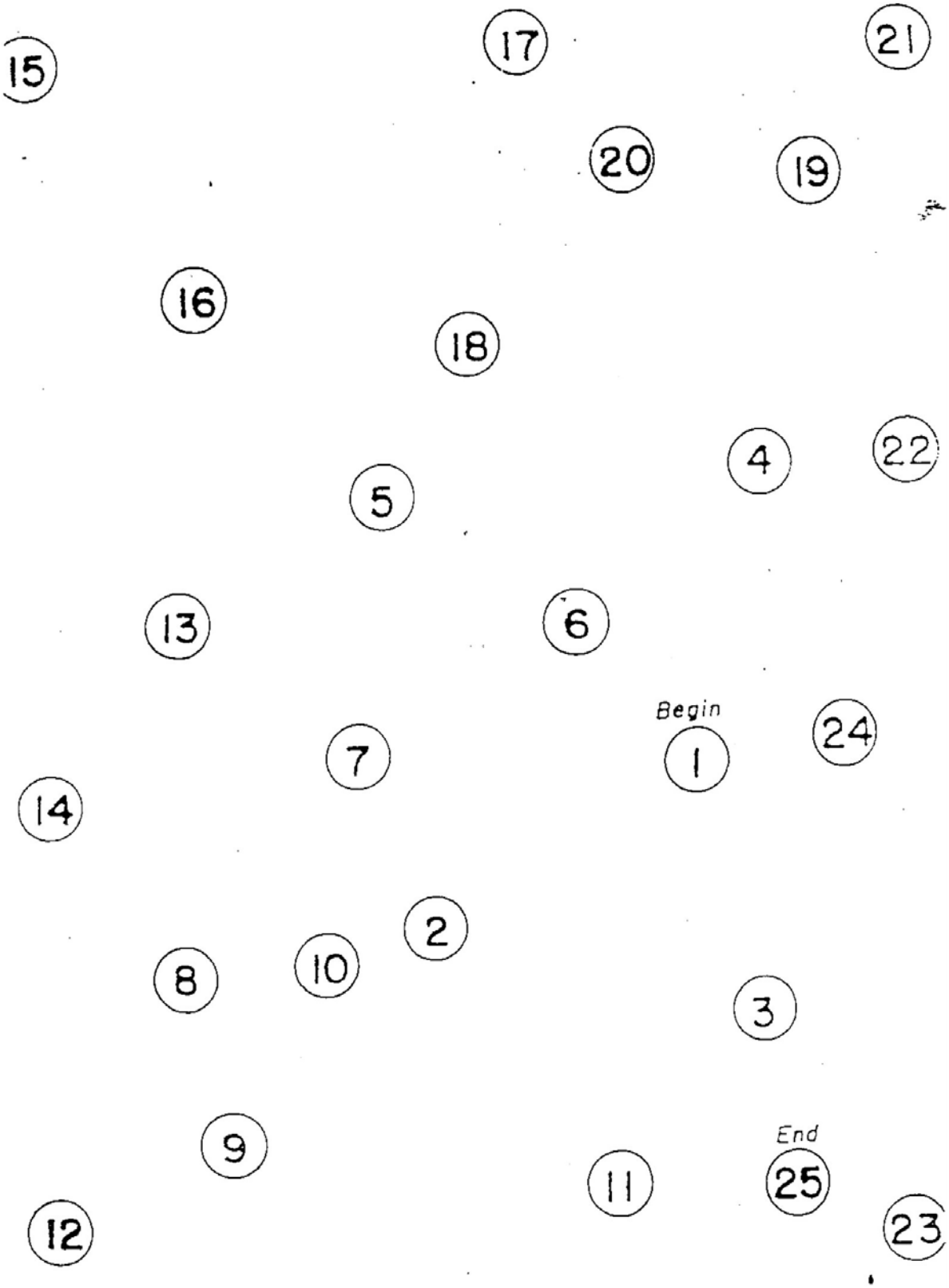
Appendix 7. Raven Test (SET A, number 1)



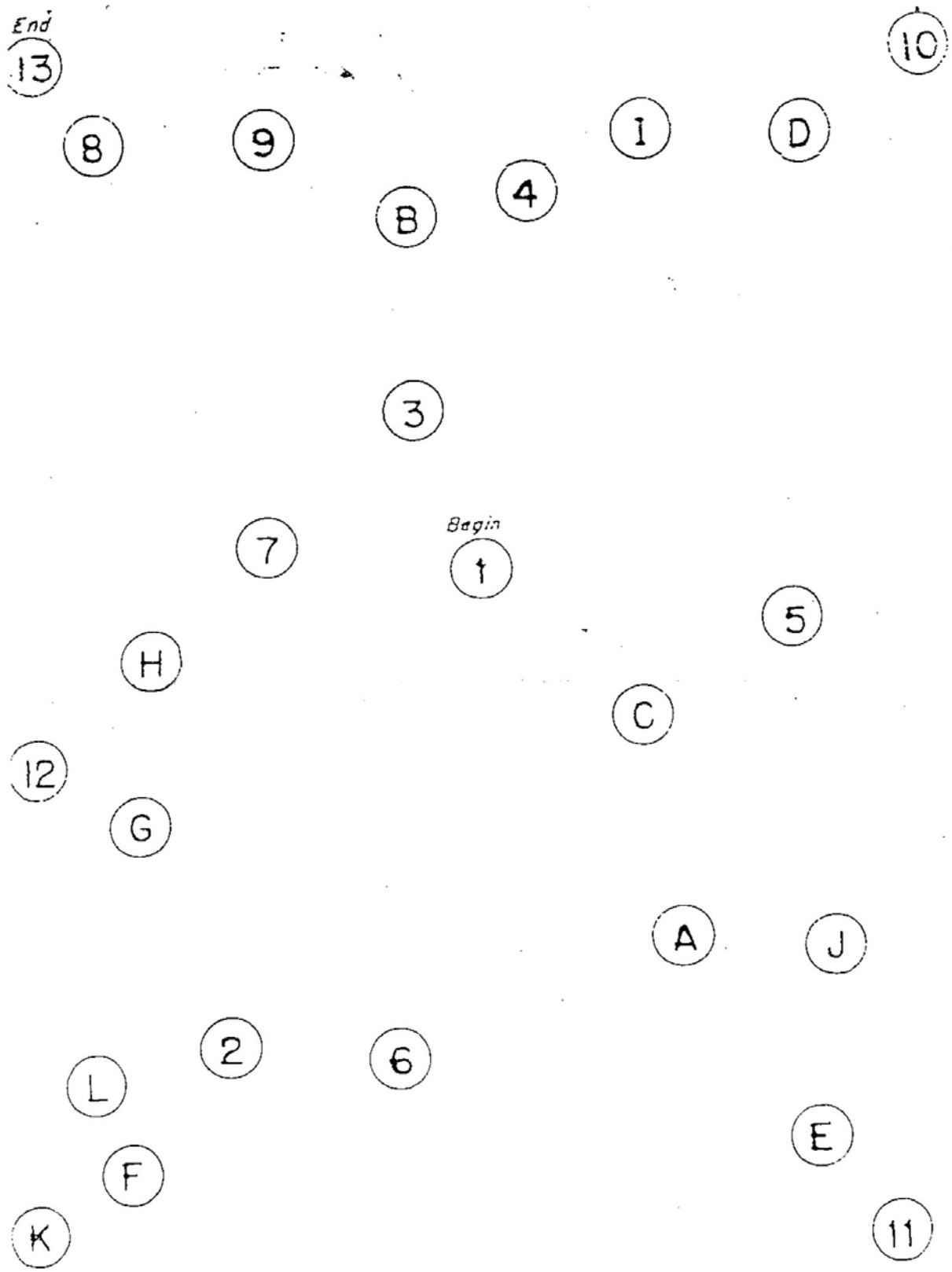
Appendix 8. Wisconsin Card Sorting Test (four main cards)



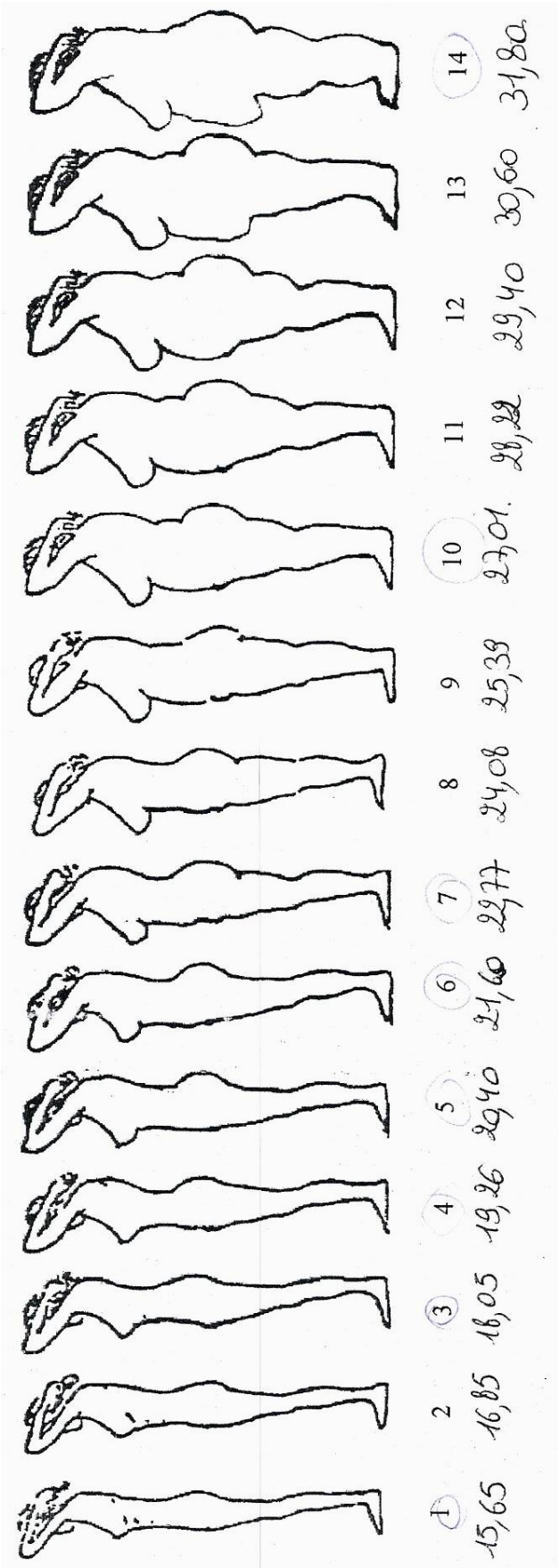
Appendix 9. TRAIL MAKING TEST PART A



Appendix 10. TRAIL MAKING TEST PART B



Appendix 11. Body Figure Scale



Appendix 12. State -Trait Anxiety Inventory

A number of statements which people have used to describe themselves are given below. Choose the response that indicates how you generally feel and place an "X" in the appropriate column. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		Almost Never	Sometimes	Often	Almost Always
1.	I feel pleasant	_____	_____	_____	_____
2.	I feel nervous and restless	_____	_____	_____	_____
3.	I feel satisfied with myself	_____	_____	_____	_____
4.	I wish I could be as happy as others seems to be	_____	_____	_____	_____
5.	I feel like a failure	_____	_____	_____	_____
6.	I feel rested	_____	_____	_____	_____
7.	I am "calm, cool and collected"	_____	_____	_____	_____
8.	I feel that difficulties are piling up so that I cannot overcome them	_____	_____	_____	_____
9.	I worry too much over something that really doesn't matter	___	____	_____	_____
10.	I am happy	_____	_____	_____	_____
11.	I have disturbing thoughts	_____	_____	_____	_____
12.	I lack self-confidence	_____	_____	_____	_____
13.	I feel secure	_____	_____	_____	_____
14.	I make decisions easily	_____	_____	_____	_____
15.	I feel inadequate	_____	_____	_____	_____
16.	I am content	_____	_____	_____	_____
17.	Some unimportant thought runs through my mind and bothers me	_____	_____	_____	_____
18.	I take disappointments so keenly that I can't put them out of my mind	_____	_____	_____	_____
19.	I am a steady person	_____	_____	_____	_____
20.	I get in a state of tension or turmoil as I think over my recent concerns and interest	_____	_____	_____	_____

Appendix 13. Positive Affectivity Negative Affectivity Schedule

	Not at all (1)	A few (2)	average (3)	A lot (4)	extremely (5)
interested	☐	☐	☐	☐	☐
distressed	☐	☐	☐	☐	☐
excited	☐	☐	☐	☐	☐
upset	☐	☐	☐	☐	☐
strong	☐	☐	☐	☐	☐
guilty	☐	☐	☐	☐	☐
scared	☐	☐	☐	☐	☐
hostile	☐	☐	☐	☐	☐
enthusiastic	☐	☐	☐	☐	☐
proud	☐	☐	☐	☐	☐
irritable	☐	☐	☐	☐	☐
alert	☐	☐	☐	☐	☐
ashamed	☐	☐	☐	☐	☐
inspired	☐	☐	☐	☐	☐
nervous	☐	☐	☐	☐	☐
determined	☐	☐	☐	☐	☐
attentive	☐	☐	☐	☐	☐
jittery	☐	☐	☐	☐	☐
active	☐	☐	☐	☐	☐
afraid	☐	☐	☐	☐	☐

Appendix 14. Toronto Alexithymia Scale - 20 items

Please indicate how strongly you agree or disagree with each proposition by marking the number that corresponds to your choice

		1. I strongly disagree 2. I disagree. 3. Neither I disagree, nor I agree 4. I agree 5. I strongly agree	**1**	**2**	**3**	**4**	**5**	
[redacted]	**1**	I am often confused about what emotion I am feeling	☐	☐	☐	☐	☐	[redacted]
[redacted]	**2**	It is difficult for me to find the right words for my feelings	☐	☐	☐	☐	☐	[redacted]
[redacted]	**3**	I have physical sensations that even doctors don't understand.	☐	☐	☐	☐	☐	[redacted]
[redacted]	**4**	I am able to describe my feelings easily	☐	☐	☐	☐	☐	[redacted]
[redacted]	**5**	I prefer to analyze problems rather than just describe them	☐	☐	☐	☐	☐	[redacted]
[redacted]	**6**	When I am upset, I don't know if I am sad, frightened or angry	☐	☐	☐	☐	☐	[redacted]
[redacted]	**7**	I am often puzzled by sensations in my body	☐	☐	☐	☐	☐	[redacted]
[redacted]	**8**	I prefer to just let things happen rather than to understand why they turned out that way	☐	☐	☐	☐	☐	[redacted]
[redacted]	**9**	I have feelings that I can't quite identify	☐	☐	☐	☐	☐	[redacted]
[redacted]	**10**	Being in touch with emotions is essential	☐	☐	☐	☐	☐	[redacted]
[redacted]	**11**	I find it hard to describe how I feel about people	☐	☐	☐	☐	☐	[redacted]
[redacted]	**12**	People tell me to describe my feelings more	☐	☐	☐	☐	☐	[redacted]
[redacted]	**13**	I don't know what's going on inside me	☐	☐	☐	☐	☐	[redacted]
[redacted]	**14**	I often don't know why I am angry	☐	☐	☐	☐	☐	[redacted]
[redacted]	**15**	I prefer talking to people about their daily activities rather than their feelings	☐	☐	☐	☐	☐	[redacted]
[redacted]	**16**	I prefer to watch "light" entertainment shows rather than psychological dramas	☐	☐	☐	☐	☐	[redacted]
[redacted]	**17**	It is difficult for me to reveal my innermost feelings, even to close friends	☐	☐	☐	☐	☐	[redacted]
[redacted]	**18**	I can feel close to someone, even in moments of silence	☐	☐	☐	☐	☐	[redacted]
[redacted]	**19**	I find examination of my feelings useful in solving personal problems.	☐	☐	☐	☐	☐	[redacted]
[redacted]	**20**	Looking for hidden meanings in movies or plays distracts from their enjoyment	☐	☐	☐	☐	☐	[redacted]