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## **Cognitive-motivational model of obesity. Motivational mechanisms and cognitive biases underlying the processing of food-related images by people with excess body weight.**

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### **Summary**

Obesity is a constantly escalating problem in all age groups. In the face of ubiquitous images of food, colourful advertisements of high-calorie meals and beverages, it is necessary to examine the role of the memory and attention mechanism in the processing of these stimuli. Knowledge regarding this subject will surely significantly contribute to the improvement of prevention and management of obesity programs designed to prevent secondary psychological difficulties, including depression.

This paper presents cognitive-motivational model of obesity, according to which the description of mechanisms of eating disorders occurrence should include not only motivational factors but also the cognitive ones. The paper shows theoretical perspectives on the problem of obesity irrespective of its origin, as well as the latest empirical reports in this field. The presented survey demonstrates the lack of explicit research findings related to the processing of high and low-calorie food images by persons with excess weight. It seems that the knowledge of the basic mechanisms involved in the processing of these stimuli and the exploration of this phenomenon will allow to improve programs whose objective is to prevent obesity.

**Key words:** obesity, attention, memory

### **Introduction**

According to the data provided by the World Health Organization [1], the incidence rate of chronic non-communicable diseases has increased over the recent years. Obesity is considered to be one of them and as such in 1997 it was declared by the WHO as a disease requiring treatment and leading to numerous complications and to the shortening of the life-span [2]. Statistics show that obesity is an escalating problem

[3–6] which is the sixth most significant risk factor for mortality [7, 8]. The largest proportion of obese persons can be observed in the USA, where in 2005 33.6% of people were overweight and 26.9% obese [9]. The research carried out by National Health and Nutrition Examination Survey (NHANES) reveals that the percentage of obese people in the years 2009–2010 increased in the USA to the level of 35.7% [6]. The WOBASZ study (National Health Survey in Poland) [10] conducted in Poland in the years 2003–2005 showed that 50% of women and 61% of men aged 20 to 74 suffer from obesity and being overweight. According to the data of GUS (The Polish Central Statistical Office) [11], 54% of the population of adult Poles are either overweight or obese; 64% of that are men and 46% – women. The lowest prevalence of obesity can be observed in China, Mali, Japan, Sweden and Brazil [12].

Obesity influences largely the entire functioning of a person, including physical as well as psychological and social areas. It causes many somatic complications such as numerous diseases affecting circulatory and digestive systems, neurological disorders, endocrine disturbances, diabetes or cancer [13, 14] as well as physical disability [15] and psychological disorders [16]. There are also reports linking obesity with the occurrence of Alzheimer's disease [17].

The escalation of the problem of obesity and its serious consequences results in a growing amount of research on various aspects of functioning of people with excess body weight. One of the areas in which such people are observed to function differently is the cognitive sphere. The differences concern both particular processes such as attention and memory, as well as the overall processing of information. For instance, the studies reveal that in comparison to healthy-weight individuals, persons with excess body mass do worse at attention, short-term memory or verbal memory tests. They are also characterized by a poorer ability to retain information in their memory and react in accordance with the adopted logical concept [18–20]. The more serious deficit in functioning concerns vigilance and the turning of attention or spatial memory of the visual stimuli [21] as well as concentration, resilience and resistance to distractors [22]. It is worth noting that the amount and ingeniousness of research in this area is impressive [23, 24].

In order to examine the phenomenon of continuously increasing BMI, it seems of importance to analyse the way in which obese people process stimuli significant to them, i.e. food-related cues. The examination of these mechanisms and better understanding of food-related activity may lead to the designing of more effective psychological intervention programs [19].

Obesity very often does not stem either from disorders in metabolic processes or the phenomenon of emotional overeating where food-related activities are supposed to reduce anxiety or fear. In reaction to the recent common availability of high-calorie food, the term 'external eating' was introduced [25]. In this case food-related activities are characterized by disorders affecting the sensation of hunger and oversensitivity to external factors such as for instance the sight or smell of food [26] as well as to the tendency to start eating after being exposed to food [27].

### *Motivational mechanisms of obesity*

Nijs, Franken and Booij [28] created a model of food-related activities based on the motivational model of dopaminergic reward system. The authors define obesity as a symptom of addiction to substances present in food and to the activation of the reward system, which in consequence leads to the increase of appetite and consumption of the rewarding substance. According to the incentive sensitization model of obesity, obese individuals are particularly sensitive to signs of the presence of food in their environment which attract their attention as reward-related cues.

The cognitive and behavioural concept assumes that the emergence and persistence of food disorders can be explained by biases in processing food-related information as well as information related to the shape and size of the body [29]. This model is consistent with the goal conflict model [26] according to which food-related activities are a function of two incompatible goals – to enjoy eating and to control weight. These goals regulate the eating activity in two ways: they control the processing of information in order to increase the probability of actions beneficial to their fulfilment and they regulate attention processes increasing the probability of retaining the goal in the brain. In accordance with this perspective, if the two systems are activated at the same time, the one with higher priority automatically and beyond a person's consciousness inhibits the activation of the other one. When the active goal is related to eating enjoyment, then the high-calorie food cues grab and hold the person's attention. Due to that, for obese people the sensory data which provides cues to eating evokes particular emotions and motivations automatically attracting attention, which brings about the fundamental cause of dietary failure, namely, the dominance of the hedonistic goal to enjoy eating over the goal to control weight.

### *Cognitive mechanisms of obesity*

Considering the fact that for individuals with excess weight high-calorie food is particularly rewarding, this type of food is an important cue grabbing their attention. This may lead to the vicious circle mechanism – food images trigger appetite, which turns our attention to them, while processing these images increases food craving. The innate or acquired sensitization of the reward system during the processing of food-related cues leads to cognitive biases [30] including attentional ones which are defined as deviations in the processing of information that evokes emotions which is motivationally more important than other, more neutral emotions. The processes of enhanced detection lead to overeating caused by the increased attention to these motivationally more important cues, by the strong engagement of attention in the processing of the cues and by the hindered and delayed turning of attention away from them [27].

### *Cognitive-motivational model of obesity*

The description of mechanisms of occurrence of eating disorders should include not only motivational factors but also the cognitive ones. One of the models contrasting

the above determinants of obesity is the concept of Nijs [31]. The author assumes that in the case of obese individuals the presence of food or a food-related stimulus automatically activates positive associations and liking, and subsequently – attention and motivational orientation biases, which in turn stimulates enhanced food-related activity.

Nijs emphasizes that her approach is in accordance with the cognitive-behavioural theory of eating disorders presupposing strongly activated food, weight and body shape schemata. These cognitive structures are associated with the self-schema and self-worth schema and that is why they strongly affect emotions, thoughts and behaviour through the modification of perception and evaluation processes.

#### *The results of research on attention process of obese individuals*

The attention mechanism in the processing of food-related stimuli is examined by means of the procedure of the Modified Stroop Effect Test [32] or the dot probe task [33]. Methodological problems connected with the frequency of words and the choice of control words [34] point to the superiority of the second method. However, even the studies carried out by means of the same procedure and slightly different in terms of methodology provide inconsistent results. Werthmann, Roefs, Nederkoorn, Mogg and Bradley [34] investigated attention processes through recording eye movement during a dot-location task. During the research pairs of pictures were presented (time 2,000 ms); one of them showed food, the control showed musical instruments. Next, one of the images was replaced by a dot and the task of the participant was to react as quickly as possible by pressing a button indicating location of the dot. Reaction time to the dot in the place of the experimental and control pictures was subsequently compared. The speed of the first fixations on food images and the gaze duration was recorded. The study showed that obese individuals turn their attention to food pictures more often and faster than healthy individuals. It did not, however, identify differences in the gaze duration for these images. The authors concluded that obese people employ a cognitive technique of reducing allocation of attention to food stimuli. The research did not prove any differences in the speed of dot location in the place of both types of images, which according to the authors was associated with the long stimulus exposition time.

Castellanos et al. [35] used the same procedure to manipulate the level of hunger. Half of the participants were served food and later exposed (2,000 ms) to pairs of images: food and control ones. In the normal weight group only the hungry people directed their gaze firstly at food and only they held their gaze longer. In the group consisting of obese participants, regardless of whether a person was hungry or not, the first gaze was always directed at food and the gaze duration was longer. For healthy-weight people hunger makes food a motivationally important cue [36], while in the case of the obese people food always attracts attention regardless of the level of hunger.

Nijs, Muris, Euser and Franken [30] carried out research on attention using the same procedure, showing experimental images (food), positive images (babies) and neutral images (office-related items). Brain activity was monitored as well (EEG). Next, a bogus taste task to assess high-calorie products (chocolate, crisps, peanuts) was

conducted and the number of consumed calories was calculated. In order to investigate the mechanisms of automatic and free direction of attention, the exposition time to pairs of images was differentiated – it was 100 ms or 500 ms. The researchers did not obtain any differences in the frequency or duration of fixation on food. However, the analysis of reaction times during the dot-location task showed that, under the conditions of shorter exposure, obese people directed their attention to food faster than the control group, especially in the conditions of hunger. In the case of longer exposure and regardless of hunger or satiety all participants maintained their attention. It was also shown that the obese participants consumed more high-calorie snacks, especially in the conditions of hunger. The healthy-weight individuals did not differ in terms of intake of the high-calorie snacks irrespective of the conditions, while in the group of obese people the difference was significant.

In the study aimed at analysing the processing of food-related information by persons of different body weight particular attention should be paid to the examination of brain activity. Research results regarding this area are also inconsistent. During one of the studies conducted by Nijs, Franken and Muris [37] the researchers presented images of high-calorie food for 2 seconds and recorded the activity of the cerebral cortex in places responsible for motivational tendencies (P3, LPP). The authors of the research did not report any differences between people with healthy and excess body weight. They found only one common feature – food-related images cause more intensive response in those areas than the neutral ones. Stice, Spoor, Bohon, Veldhuizen and Small [38] observed brain activity (fMRI) of adolescents in the conditions of imagining calorific food and in the conditions of its consumption. Obese individuals displayed stronger activity of regions responsible for sensory experience and enjoyment. What is more, during consumption they showed decreased activation of areas associated with the motivational system and experiencing enjoyment. Thus, pleasant feelings which are rich in terms of sensory experience accompany the imagining, but the degree of enjoyment during consumption is lower. The authors seek causes of this situation in the lower transmission of dopamine. Stice, Yokum, Blum and Bohon [39] studied women who had gained weight prior to the research and confirmed their claim that the obese people who overeat to compensate for the worse functioning of the reward system have fewer striatal receptors which respond to dopamine and at the same time they are characterized by a weaker responsiveness to stimuli associated with tasty food. Consequently, low sensitivity of the reward system increases the risk of overeating.

The research by Calitri, Pothos, Tapper, Brunstrom and Rogers [33] proved that individuals able to control the direction of their attention possess stronger control over their weight in the presence of food-related stimuli. The authors divided their study in two phases – during the first one, the participants took the Stroop test based on words signifying healthy (low-calorie) and unhealthy (high-calorie) food. In addition, during this phase the BMI of every participant was calculated. After a period of 12 months the changes in the BMI were analysed and the research concluded that the previously identified tendency to direct attention to words connected with unhealthy food was linked with the increase of BMI over the year.

*The results of research on memory processes of obese individuals*

Memorizing is a result of the engagement of attention and deeper processing of information. If obese people show particular vigilance with respect to food-related stimuli and maintain their attention longer on them, they should unintentionally remember them better. Soetens and Braet [40] tested attention mechanisms and memorization of words of obese people and concluded that, compared to lean individuals, obese people find more words related to high-calorie food (e.g. cookie, pizza) in a word scramble than words which are not food-related. Docteur, Urdapilleta, Defrance and Raison [41], in turn, investigated the explicit and implicit memory bias for words related to food, shape and parts of the body in obese and normal weight persons. Implicit memory was studied with the use of word completion stem test which involved presenting the 3 first letters of a word as a clue, while the explicit memory was analysed by means of a free recall task. The results showed that obese persons demonstrate significantly better implicit memory of food-related words as compared to the not food-related ones. Measurements of explicit memory did not identify any differences. Similar findings were obtained by Conforto and Gershman [42].

When discussing obesity, memory processes can be seen in the context of results as well as causes of this phenomenon. Higgs, Robinson and Lee [27] claim that the memory of emotions and enjoyment associated with a given type of food is a factor influencing food choices in the future. This opinion is shared by Robinson [43]. The researcher claims that positive memories increase anticipated satisfaction from eating as well as the probability of choosing a given type of food in the future. Moreover, he stresses that a change in memory resources may lead to changes in behaviour and food choices. Higgs et al. [44] concluded, on the basis of their research, that people busy with thinking about food and holding food-related data in their working memory show particular ease of discovering food cues in their environment. The authors of the study suggest that working memory is a mechanism involved in the creation of attentional biases in the processing of food-related stimuli.

Studying memory concerning a particular type of food may contribute to a practical use of these mechanisms to regulate behaviours. Bernstein and Loftus [45] studied the role of false memories connected with food. They concluded that suggesting feeling bad and having health problems modifies preferences and behaviour and that implementing unpleasant, false memories may dissuade from eating high-calorie food. Similarly, positive false memories may encourage people to eat low-calorie meals.

Due to the fact, that the above review demonstrates the lack of explicit research findings related to the processing of high and low-calorie food images by persons with excess weight, it would be legitimate to design and carry out a series of research aimed at their unification. Inconsistency of results presented in the literature could be linked not only to the differences in the research methodology, but also to the existence of individual differences in terms of ability to control stimuli or responses which were not included in the research. Impulsivity or ability to control an action may be a mediating factor in the relationship between obesity and cognitive functioning [46].

Research results and procedures discussed in this paper, after being verified in Poland, may be used in therapeutic and diagnostic work. They may be used in the process of formulating anew cognitive schemes of own body weight, body shape, modification of perception and assessment of high-calorie food. The presented literature overview indicates, that when treating obesity it may turn effective to create a system of alternative forms of reward, unrelated to food. It would be also appropriate to use desensitization procedure responsible for disappearance of positive associations with high-calorie food. Motivational technique of formulating anew a goal – from hedonistic pleasure to pleasure derived from self-control in terms of food habits – could be also effective from therapeutic point of view.

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