



## Review

# Reward-related decision making in eating and weight disorders: A systematic review and meta-analysis of the evidence from neuropsychological studies



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## ABSTRACT

Eating disorders (EDs) and overweight/obesity (OW/OB) are serious public health concerns that share common neuropsychological features and patterns of disturbed eating. Reward-related decision making as a basic neurocognitive function may trans-diagnostically underlie both pathological overeating and restricted eating. The present meta-analysis synthesizes the evidence from  $N = 82$  neuropsychological studies for altered reward-related decision making in all ED subtypes, OW and OB. The overall effect sizes for the differences between currently-ill ED patients and OW/OB people and controls were Hedge's  $g = -0.49$  [CI:  $-0.63$ ;  $-0.35$ ], and Hedge's  $g = -0.39$  [CI:  $-0.53$ ;  $-0.25$ ], respectively. Decision making was found to be altered to similar degrees in all ED subtypes and OB. Effect sizes, however, diverged for the different measures of decision making. Adolescents appear to be less affected than adults. When foods were used as rewarding stimuli, decision making was found to be intact in OB. The findings support that altered general reward-related decision making is a salient neuropsychological factor across eating and weight disorders in adulthood.

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## 1. Introduction

Eating disorders (EDs) are common mental disorders with heightened morbidity and all-cause mortality (Treasure et al., 2010) and comprise Anorexia Nervosa of the restricting type (AN-r) and binge/purge type (AN-b), Bulimia Nervosa (BN), and Binge Eating Disorder (BED). Central to ED psychopathology are disturbed patterns of eating behavior. Patients with AN-r achieve and maintain their severely low body weight solely by dietary restraint and excessive physical activity. Patients with AN-b show also purging behavior (e.g., self-induced vomiting or laxative misuse) to regulate their body weight. In contrast to AN-r, bulimic type EDs (AN-b, BN, and BED) are characterized by recurrent episodes of uncontrollable overeating (i.e. binge eating) with (in the case of AN-b and BN) and without (in the case of BED) compensatory/purging behaviors (APA, 2013).

Obesity (OB) and overweight (OW) are not EDs in the narrow sense but conditions defined by a body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup> (OB) or between 25 and 30 kg/m<sup>2</sup> (OW), respectively, which results mainly from overeating although a regular meal time structure is still preserved (O’Rahilly and Farooqi, 2008; Raman et al., 2013; Wang et al., 2001). Both, OW and OB become mostly chronic and predispose to several somatic diseases such as diabetes, hypertension, cardiovascular disease, and different types of cancer (Kaiser, 2013; Lu et al., 2014; Wang et al., 2011; Yoshimoto et al., 2013). The prevalence of OW/OB has increased dramatically over the past two decades and is considered as one of the most urgent public health concerns (Swinburn et al., 2011; WHO, 2000). Thus, there is a great need to identify risk and maintenance factors for eating and weight disorders that may serve as targets for the development of novel interventions and the refinement of existing treatment approaches.

### 1.1. Commonalities among eating disorders and overweight/obesity

Co-morbidity rates are high between EDs (only BN and BED) and OW/OB (Villarejo et al., 2012). Moreover, patients with bulimic-type EDs (i.e. AN-b, BN, BED) and those with OW/OB share similar patterns of addictive and compulsive food consumption and overeating (Goldschmidt et al., 2008; Hilbert et al., 2014; Hill, 2007; Marcus et al., 1992), as well as biological and environmental risk factors (Bulik et al., 2003; Haines et al., 2010). Disturbed eating patterns in EDs and OW/OB as well as regularly increased physical activity in AN and BN may, at least in part, be attributable

to neurocognitive alterations of reward processing and approach-avoidance behaviors towards food, body shape, and exercising (Fladung et al., 2010; Giel et al., 2013; O’Rahilly and Farooqi, 2008; Raman et al., 2013; Wang et al., 2001). Indeed, both EDs and OW/OB are associated with alterations in several neurocognitive functions (Fitzpatrick et al., 2013; Vainik et al., 2013; Wu et al., 2014). These similarities across sub-groups may indicate that common mechanisms underlie the whole spectrum of eating and weight disorders (Williamson et al., 2002).

The present systematic review and meta-analysis addresses altered reward-related decision making as a key construct that may help to understand disturbed eating behavior across the broad spectrum of eating and weight disorders. An undue preference for immediate rewards and tolerance of risk in favor of desired outcomes may constitute a driving factor underlying excessive food intake in bulimic EDs and OW/OB. Similarly, it may contribute to the strict avoidance of food intake in AN-r. This paradoxical notion could be explained by the phenomenon that, in this particular population, food restriction (that ultimately results in skinniness and low weight) appears to be rewarding as well, despite a range of significant negative mid- and long-term consequences in terms of mental and physical health as well as social well-being.

### 1.2. Reward-related decision making as a cognitive construct underlying eating and weight disorders

Emerged from neuro-economic theories, reward-related decision making is considered a pervasive neuro-computational process that occurs whenever an individual has to make a choice from several alternative options on the basis of subjective values (Rangel et al., 2008). More specifically, reward-related decision making is conceptualized as a cognitive process that involves the representation and assignment of values and probabilities to different options, the selection of an option based on this value assignment, the execution of specific behavior that is expected to lead to the desired outcome, the evaluation of the outcome and the learning and updating of the evaluation and action-selection process (Rangel et al., 2008). This process is deeply rooted in the neurobiology of the human brain (Dixon and Christoff, 2014; Liu et al., 2011; Silvetti et al., 2013). A disruption to the efficacy of this process is considered to play an important role in impulsive behaviors and thus in the development and maintenance of many mental disorders such as addictive and eating disorders (Dawe et al., 2004) and also in neurological diseases (Ryterska et al., 2013).

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