Steward T, Mestre-Bach G, Vintró-Alcaraz C, Agüera Z, Jiménez-Murcia S, Granero R, Fernández-Aranda F. (2017). Delay discounting of reward and impulsivity in eating disorders: from anorexia nervosa to binge eating disorder. ***European Eating Disordorders Review, 25(6), 601-606.*** **doi: 10.1002/erv.2543.**

Abstract

Evidence points to eating disorder (ED) patients displaying altered rates of delay discounting (one's degree of preference for immediate rewards over larger delayed rewards). Anorexia nervosa (AN) patients are believed to have an increased capacity to delay reward, which reflects their ability to override the drive to eat. Contrarily, binge eating disorder (BED) patients are associated with a reduced predisposition to delay gratification. Here, we investigated monetary delay discounting and impulsivity in 80 adult women with EDs (56 AN and 24 BED), diagnosed according to DSM-5 criteria, and 80 healthy controls (HC). AN-restrictive (AN-R) subtype patients showed less steep discounting rates than BED and AN-bingeing/purging (AN-BP) subtype patients. Compared to HCs and AN-R patients, BED and AN-BP patients presented higher delay discounting, and positive and negative urgency levels. Our findings suggest that reduced caloric intake in AN-R patients is associated with disproportionate self-control, whereas bingeing behaviors could be more driven by emotional states and impulsivity traits.

Keywords: eating disorders; delay discounting; impulsivity; anorexia nervosa; binge eating disorder.

Introduction

Certain personality characteristics, such as rigidity or perfectionism are often related to anorexia nervosa-restricting subtype (AN-R) (National Institute for Clinical Excellence, 2004), whereas other features, such as impulsivity and emotion dysregulation are commonly associated to bulimic-spectrum disorders, encompassing anorexia nervosa-bingeing/purging subtype (AN-BP), bulimia nervosa (BN), and binge eating disorder (BED) (Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Claes, Vandereycken, & Vertommen, 2002; Lavender & Mitchell, 2015; Waxman, 2009). Likewise, the extent to which an individual chooses immediate gratification over larger, delayed rewards varies across psychiatric disorders (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017; Story, Moutoussis, & Dolan, 2015) and contexts (Kaplan, Reed, & Jarmolowicz, 2016; Lempert & Phelps, 2016). This tendency to devalue rewards according to the temporal delay of their receipt is known as delay discounting or temporal discounting, and is normally measured by having subjects choose between a smaller-immediate reward or a larger-delayed reward (e.g. 'Would you prefer € 45 now or € 88 in 7 days?') (Madden & Bickel 2009). Being more prone to choosing immediate rewards has been associated with clinical conditions, such as gambling disorder (Steward et al., 2017), substance abuse (Grant & Chamberlain, 2014), and obesity (Epstein, Salvy, Carr, Dearing, & Bickel, 2010).

In the case of EDs, evidence points to a phenotypic overlap across disorders with respect to delay discounting (Bartholdy et al., 2017; Stojek & MacKillop, 2017). EDs characterized by higher levels of impulsivity, namely BN and BED, are associated with a preference for immediate rewards, regardless of whether the reward is monetary (Davis, Patte, Curtis, & Reid, 2010; Kekic et al., 2016) or a food reward (Manwaring, Green, Myerson, Strube, & Wilfley, 2011). On the other hand, being overly cautious and choosing delayed rewards more than is expected has been linked to AN (Decker, Figner, & Steinglass, 2015; Steinglass et al., 2012, 2017). This tendency is thought to reflect the unusually elevated level of self-control found in AN patients and possibly reflect a vulnerability marker for the disorder (Stojek & MacKillop, 2017). By regularly forgoing the

immediate rewards provided by food in favor of the longer-term goal of reducing body weight, the behavioral habit of not discounting rewards is increasingly understood to be a potential maintenance factor for AN (Walsh, 2013). Likewise, in the case of EDs associated with excess weight, the inability to resist the temptation of immediate rewards (i.e. unhealthy, palatable foods) is believed to be a detrimental influence on adherence to the dietary guidelines that commonly form part of BED treatment programs (Citrome, 2015).

Impulsivity factors, such as a lack of premeditation and acting out rashly in response to extreme moods, have also been linked to heightened delay discounting (Stojek, Fischer, Murphy, & MacKillop, 2014; VanderBroek-Stice, Stojek, Beach, vanDellen, & MacKillop, 2017). The UPPS-P model contemplates impulsivity as a multidimensional construct and utilizes five separate subscales to assess impulsive behavior and traits. Positive urgency refers to the tendency to act impulsively when undergoing positive affect; negative urgency reflects the propensity to act impulsively when experiencing negative affect; lack of perseverance shows the tendency to not persist in an activity that can be arduous or boring; lack of premeditation refers to the tendency to act without considering the consequences of an action; and sensation seeking indicates one's disposition to seek exciting experiences (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010).

In the EDs, an interaction between lack of premeditation, negative urgency and bingeing and purging behaviors has been identified (Anestis, Smith, Fink, & Joiner, 2009; Bardone-Cone, Butler, Balk, & Koller, 2016), with these maladaptive behaviors often being carried out in negative mood states (Fischer, Smith, & Anderson, 2003). Contrarily, AN-R patients tend to present reduced levels of impulsivity-related traits on the UPPS-P (Claes, Vandereycken, & Vertommen, 2005). It must be highlighted, however, that there is a dearth of studies evaluating both trait and choice (i.e. delay discounting) impulsivity across EDs when taking AN subtypes into account.

Aims

As such, in this study, we sought to assess delayed discounting and impulsivity in extreme-eating/weight conditions, in comparison with healthy controls (HC). Given the aforementioned

differences in impulsivity features, we also sought to examine whether delay discounting tendencies differed between AN-BP or AN-R subtype patients. We hypothesized that increased delay discounting and impulsivity levels would be associated with bulimic-spectrum disorders (AN-BP and BED), whereas these tendencies would be reduced in AN-R patients.

Methods

Sample and procedure

Our sample was made up of 80 ED female patients (37 AN-R, 19 AN-BP, and 24 BED patients), who were recruited from consecutive referrals to the ED Unit within the Department of Psychiatry at Bellvitge University Hospital (Spain). Patients were originally diagnosed according to DSM-IV-TR (APA, 2000) criteria by means of the Structured Clinical Interview for DSM Disorders-I (First, Gibbon, Spitzer, & Williams, 1996). However, these DSM-IV-TR diagnoses were reanalyzed *post hoc* using DSM-5 criteria (APA, 2013). These patients were compared to 80 healthy controls (HC) who were screened to ensure they met study inclusion criteria. The study exclusion criteria were the following: being male, the presence of an organic mental disorder, an intellectual disability, or a history of EDs (in the case of HC).

Unit staff psychologists and psychiatrists carried out clinical evaluations during two structured face-to-face interviews. The first was conducted to provide information on current ED symptoms, antecedents and other psychopathological data of interest. The second interview consisted of a psychometrical assessment and eating behavior monitoring through daily reports. HCs were provided with the study questionnaire following screening.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The Bellvitge University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was obtained from all participants.

Measures

ED symptomatology was assessed via the validated Spanish version of the Eating Disorders Inventory-2, EDI-2 (Garner, 1998) (internal consistency measured by Cronbach's alpha for the total

score in the study sample was excellent, α=.921). The UPPS-P Impulsive Behavior Scale-UPPS (Verdejo-García et al., 2010) was used to measure impulsivity-related traits (internal consistency for the study sample was good, ranging from .789 in lack of perseverance to .923 in positive urgency). On the UPPS-P, individuals are asked to consider acts/incidents during the last 6 months when rating their behavior and attitudes.

Delay discounting was assessed using a validated paper-and-pencil monetary choice task (Kirby, Petry, & Bickel, 1999). This task elicits individual inter-temporal discount rates (*k*) by providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of these questions was designed to correspond to a different *k* value, which represents the amount of discounting of the later reward that renders it equal to the smaller reward. The task is scored by calculating where the respondent's answers place him/her amid reference discounting curves, with placement on steeper curves indicating higher levels of choice impulsivity. Point single *k* parameter-estimates can be obtained to represent the overall rate of discounting, but also for items with small, medium and large monetary rewards (Kirby et al., 1999). Overall *k* values can range from 0 (selection of the delayed reward option on all items, or no discounting) to 0.25 (selection of the immediate reward option on all items). As previous studies have shown a magnitude effect on discounting rates (*k*-values decrease as the amount of the rewards increase), *k* values were separately estimated using three magnitude categories (Kirby & Petry, 2004): small (€25–35), medium (€50–60), and large (€75–85) delayed rewards. The distributions of *k* values were normalized using square root transformation.

Statistical analyses

Analyses were conducted with Stata15 for Windows. Comparison of discounting rates (*k* index) and impulsivity levels (UPPS-P) between groups was carried out using analysis of variance (ANOVA, including post-hoc pairwise comparisons through Scheffé's procedure). The effect size for pairwise comparisons in the ANOVA analyses was estimated through the Cohen's-*d* coefficient ($|d|>0.50$ was considered moderate effect size and $|d|>0.80$ was considered large effect size). To avoid the

increase in type-I error due to multiple statistical comparisons, the Finner's procedure was used (a method included into the Familywise error rate methods, which offers more powerful tests than the classical Bonferroni's correction).

Results

Sample characteristics

Table 1 includes a description of the sociodemographic and ED-related variables of the sample groups. Significant differences were found with respect to age, with AN-BP and BED patients being older than HCs and AN-R patients. For this reason, all pairwise comparisons controlled for this variable. As is to be expected, EDI-2 total scores were higher in the ED groups than in HCs.

---- Insert Table 1 ----

Comparison of delay discounting and impulsivity levels between groups

Table 2 contains the results of the ANOVA comparing *k*-index values (for small, medium, large and overall rewards) between groups. Compared to the other ED groups, k values for patients with AN-R were significantly lower, indicating lower levels of delayed discounting. In comparison to HC and AN-R patients, both BED and AN-BP patients presented significantly higher levels of delay discounting. No significant differences were obtained between BED and AN-BP patients in terms of k-values.

---- Insert Table 2 ---

The first panel of Figure 1 displays the group means of the *k* indexes measuring delay discounting for small, medium and large reward. The second panel includes boxplots for overall *k* indexes separated by group.

---- Insert Figure 1 ---

In terms of UPPS-P, we found significant differences between groups in multiple dimensions.. Compared to HCs, lack of premeditation scores were found to be higher in BED patients. Lack of perseverance scores were also higher in AN-BP and BED patients compared to HCs. The same

pattern held true for both positive and negative urgency. Finally, all ED groups obtained lower scores on sensation seeking compared to HCs.

Discussion

In this study we aimed to compare delay discounting and impulse behaviors in HCs and patients in extreme-weight conditions, namely AN and BED, emphasizing the differences between bulimic-spectrum disorders and AN-R.

AN-BP patients reported greater ED severity in comparison with AN-R patients, as is consistent with other studies (DeJong et al., 2013; Edler, Haedt, & Keel, 2007; Lavender et al., 2017). Likewise, as is commonly observed in clinical populations, the mean age of patients with AN was lower than with BED. For this reason, we decided to control for this variable when comparing delay discounting impulsivity measures.

The findings of the present study dovetail with previous reports of altered monetary delay discounting in patients with EDs and uphold the utility of employing spectrum models to order to understand ED behavior (Jiménez-Murcia et al., 2015; Wierenga et al., 2014). Similar to other research (Lavagnino, Arnone, Cao, Soares, & Selvaraj, 2016; Mole et al., 2015), we found that patients with BED discounted rewards more steeply than HCs. This tendency may reflect alterations in the neural subprocesses underpinning choice impulsivity such as enhanced salience of immediate reward and/or diminished prospection (Bari & Robbins, 2013). In addition, we found that patients with AN-BP subtype, though not AN-R subtype, had greater discounting than HCs. As such, increased rates of delay discounting may contribute to some of the core symptoms in bulimic spectrum disorders and could therefore represent a relevant target for intervention (Kekic et al., 2016).

Contrastingly, AN-R patients presented less steep discounting rates than the other ED groups. This result coincides with past studies identifying more conservative decision making in AN patients

(Decker, Figner, & Steinglass, 2015; Steinglass et al., 2012b, 2016). Clinically, patients with AN-R are often described as being more prone to excessive self-control than their AN-BP counterparts (Lavender et al., 2017), and our results indicate that these differences are relevant in the realm of delay discounting. Similarly, Steinglass et al., (2012) found that the significant difference in discounting in their AN sample, in comparison to controls, was largely attributable to individuals with AN-R subtype. Although our current findings require replication, they highlight the importance of separating AN subjects by subtype in future studies.

Regarding impulsivity-related traits, patients with bulimic-spectrum disorders (AN-BP and BED) showed greater levels of positive and negative urgency, as we hypothesized. This is in line with other research which found that urgency, especially negative urgency, was associated with bingeing and purging behaviors, as well as subjective loss of control of food intake (Claes et al., 2015, 2002; Fischer et al., 2003; Racine et al., 2015; Wolz et al., 2015). Being that neuroimaging evidence has suggested that negative affect increases the rewarding value of food (Bohon & Stice, 2012) and that emotion dysregulation is associated with excess weight (Steward, Picó-Pérez, et al., 2016), our results lend support to the notion that bingeing behaviors are mainly negatively reinforcing (Berner et al., 2017). However, it's worth noting that we failed to identify any differences between reported positive and negative urgency between HCs and AN-R patients. These findings raise the question whether the persistent choice of inadequate caloric intake may be linked to disproportionate self-control for AN-R patients, and more emotionally driven for AN-BP patients (Steinglass & Walsh, 2016).

Limitations and future research

Although this study has its strengths, there are limitations that should be considered when interpreting its results. First, age is a significant factor in determining delay discounting and impulsivity levels. Even though we controlled for this variable in our statistical analyses, future studies should ideally aim to match control and patients as much as is practically possible. Second, delay discounting was measured through a monetary reward task. However, taking ED features into

account, it would be of interest to assess delay discounting effects using other types of reward (e.g. food). Third, context and emotional state are understood to influence decision making and delay discounting (Kaplan et al., 2016; Lempert & Phelps, 2016), though our study did not assess the present mood or economic situation of the subjects while they completed the study measures. Finally, more longitudinal studies with larger samples are needed to estimate the predictive capacity of decision making and impulsivity dimensions on ED treatment outcome (Steward, Mestre-Bach, et al., 2016).

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Table 1. Sample description

	HC *n=80*		AN-R *n=37*		AN-BP *n=19*		BED *n=24*				
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*F*	*df*	*p*
Age (years-old)	23.0	4.43	24.3	7.22	28.6	6.56	33.6	8.59	20.35	3/156	<.001
ED related measures	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*F*	*df*	*p*
EDI-2: total score	28.2	17.2	59.2	34.8	104.7	43.1	112.0	42.6	66.75	3/156	<.001
Onset of ED (yrs-old)	---	---	18.35	6.07	18.21	4.58	20.27	8.21	0.73	3/77	.488
Duration of ED (yrs)	---	---	5.35	6.00	10.53	8.86	12.80	8.81	6.77	3/77	.002
Frequency binges	---	---	---	---	1.79	3.22	5.08	5.46	5.40	1/41	.025
Frequency purges	---	---	---	---	4.94	5.34	---	---	---	---	---
BMI present (kg/m^2)	21.62	3.22	16.15	1.83	16.65	0.88	38.86	9.70	141.5	3/156	<.001
BMI maxim. (kg/m^2)	23.09	3.94	21.95	3.80	21.40	2.87	39.75	9.35	77.16	3/157	<.001
BMI minim. (kg/m^2)	19.77	2.22	15.19	1.85	15.44	1.78	25.65	5.17	77.94	3/156	<.001

Note. HC: healthy controls. AN-R: anorexia restrictive subtype. AN-BP: anorexia bingeing-purging subtype. BED: binge eating disorder. SD: standard deviation. df: degrees of freedom. EDI-2: Eating disorder inventory-2. BMI: Body mass index

Table 2. Comparison of delayed discounting and UPPS-P impulsivity traits between groups: ANOVA.

	Means and standard deviation								Pairwise comparisons											
	HC *n=80*		AN-R *n=37*		AN-BP *n=19*		BED *n=24*		HC vs AN-R		HC vs AN-BP		HC vs BED		AN-R vs AN-BP		AN-R vs BED		AN-BP vs BED	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
k-small	.179	.116	.147	.109	.249	.136	.248	.160	.205	0.28	**.029***	**0.55†**	**.017***	**0.52†**	**.004***	**0.82†**	**.002***	**0.74†**	.995	0.01
k-medium	.148	.114	.097	.056	.214	.142	.195	.163	**.031***	**0.56†**	**.027***	**0.51†**	.079	0.34	**.001***	**1.08†**	**.002***	**0.81†**	.607	0.12
k-large	.107	.096	.075	.055	.187	.174	.161	.124	.129	0.41	**.003***	**0.57†**	**.030***	**0.55†**	**.001***	**0.87†**	**.002***	**0.89†**	.419	0.17
k-overall	.139	.100	.101	.065	.218	.149	.194	.139	.076	0.45	**.005***	**0.62†**	**.028***	**0.51†**	**.001***	**1.02†**	**.001***	**0.86†**	.476	0.16
Premedit.	21.1	4.57	19.9	5.19	21.0	7.09	23.7	5.86	.225	0.26	.919	0.02	**.037***	**0.52†**	.446	0.18	**.006***	**0.70†**	.096	0.42
Persever.	18.9	3.67	18.9	5.21	21.4	5.69	25.0	5.05	.958	0.01	**.035***	**0.51†**	**.001***	**1.38†**	**.050***	**0.51†**	**.001***	**1.20†**	**.010***	**0.67†**
Sensation S.	28.0	7.16	24.1	6.47	24.4	7.69	21.8	7.74	**.008***	**0.56†**	**.049***	**0.54†**	**.001***	**0.83†**	.888	0.04	.214	0.33	.234	0.34
P.urgency	26.1	6.13	27.2	7.99	34.3	4.83	34.0	5.27	.363	0.16	**.001***	**1.48†**	**.001***	**1.39†**	**.001***	**1.06†**	**.001***	**1.00†**	.910	0.04
N.urgency	21.3	7.28	21.7	6.58	28.9	9.45	28.6	9.42	.800	0.06	**.001***	**0.90†**	**.001***	**0.87†**	**.002***	**0.88†**	**.002***	**0.85†**	.911	0.03

Note. HC: healthy control. AN-R: anorexia restrictive. AN-BP: anorexia bingeing-purging. BED: binge eating disorder.

M: mean. SD: standard deviation. *Bold: significant pairwise comparison. †Bold: moderate (|*d*|>.50) to large effect size (|*d*|>.80).

k-square root transformation index is analyzed. Premedit.: Lack of premeditation; Persever.: Lack of perseverance; Sensation S.: Sensation seeking; P.urgency: Positive urgency; N.urgency: Negative urgency.

Figure 1. First panel: mean discount rate (Y-axis) as a function of delayed reward magnitude (X-axis); second panel: boxplot for the k overall measure.

Note. HC: healthy control. AN-R: anorexia restrictive. AN-BP: anorexia bingeing-purging. BED: binge eating disorder. k-value expressed in square root.