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THE EFFECT OF INPATIENT TREATMENT TO INHIBITORY CONTROL AND ATTENTIONAL BIAS IN INDIVIDUALS WITH EATING DISORDERS

Master's thesis

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Subtitle: Inhibitory control and attentional bias in ED

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Abstract

Impaired inhibitory control and disorder-specific attentional bias have been implicated in the etiology and maintenance of eating disorders (EDs) (Bartholdy et al., 2017; Albery et al., 2016). The intervention common to all the individuals with ED during inpatient treatment is the restoration of regular eating. Therefore, we aimed to assess the effect of restoration of regular eating to inhibitory control and attentional bias to ED specific stimuli in individuals with ED by using emotional Go/No-Go task. The possible moderating effects of duration of illness, depression, anxiety, impulsivity and ED symptoms were also assessed. The sample consisted of 62 women, of whom 19 were individuals with *bulimia nervosa* binging/purging (BN-BP), 17 with *anorexia nervosa* restrictive (AN-R), 10 with *anorexia nervosa* binging/purging (AN-BP) and 16 were psychiatrically controlled healthy individuals (HCs). The results indicated that although inhibitory control improves during treatment in individuals with AN-R to food and in BN-BP to body stimuli attentional bias to body stimuli is still present in individuals with ED despite the subtype. However, attentional avoidance towards food stimuli in individuals with AN-R decreases during treatment. BMI, depression, anxiety, impulsivity and ED symptoms did not yield any moderating effects on RTs of the first measurement to any type of stimuli.

Treatment and group interaction effect was not statistically significant in relation to any type of stimuli, however, it became significant on RTs to body stimuli after controlling the interaction with trait anxiety. Also the duration of illness affected inhibitory control and attentional bias in individuals with ED.

Keywords: eating disorders, inhibitory control, attentional bias, emotional Go/No-Go task, food restoration, inpatient treatment

Kokkuvõte

Statsionaarse ravi mõju pidurduslikule kontrollile ja tähelepanu kaldele söömishäiretega indiviididel

Häirunud pidurduslikul kontrollil ja häirespetsiifilisel tähelepanu kaldel on oluline roll söömishäirete (SH) etioloogias ning püsimisel (Bartholdy et al., 2017; Albery et al., 2016). Statsionaarse ravi jooksul taastatakse kõikidel SH indiviididel regulaarne söömine. Uuringu eesmärgiks oli emotsionaalse Go/No-Go katse abil hinnata regulaarse söömise taastamise mõju pidurduslikule kontrollile ja SH spetsiifilisele tähelepanu kaldele SH indiviididel. Samuti hinnati häire kestuse, depressiooni, ärevuse, impulsiivsuse ja SH sümptomaatika võimalikku modereerivat mõju. Valim koosnes 62 naisest, kellest 19 olid *bulimia nervosa* väljutavad (BN-BP), 17 *anorexia nervosa* piiravad (AN-R), 10 *anorexia nervosa* väljutavad indiviidid ning 16 olid psühhiaatriliste häirete suhtes kontrollitud terved indiviidid. Uuringu tulemusena leiti, et ehkki pärast söömise taastamist pidurduslik kontroll paraneb AN-R indiviididel toidu ja BN-BP indiviididel keha stiimulitele vastamisel, säilib hoolimata SH alatüübist nende tähelepanu kalle keha stiimulitele Lisaks väheneb AN-R indiviididel tähelepanu vältimine toidu stiimulite suhtes. KMI, depression, ärevus, impulsiivsus ja SH sümptomid ei omanud modereerivaid mõjusid esimese testimise reaktsiooniaegadele mitte ühegi stiimuli puhul.

Statsionaarse ravi ja grupi interaktsioon ei olnud statistiliselt olulised mitte ühelegi stiimulile, ehkki interaktsioon muutus oluliseks keha reaktsiooniaegade puhul kui kontrollisime interaktsiooni püsiärevusega. Samuti mõjutas pidurduslikku kontrolli ja tähelepanu kallet SH indiviidide puhul haiguse kestus.

Märksõnad: söömishäired, pidurduslik kontroll, tähelepanu kalle, emotsionaalne Go/No-Go katse, toitumise taastamine, statsionaarne ravi

Introduction

According to DSM-5, there are several types of eating disorders, including *anorexia nervosa* (AN), *bulimia nervosa* (BN) and binge eating disorder (BED), while *anorexia nervosa* and *bulimia nervosa* are divided into two subtypes, restrictive (AN-R, BN-R respectively) and binge/purge type (AN-BP, BN-BP respectively) based on characteristic behaviours of these individuals to control their weight. Individuals with AN-R are characterized as possessing excessive self-control, which also manifests in their ability to restrain eating. High restraint, therefore, suggests disturbances in food reward processing in individuals with AN-R (Steinglass et al., 2012). Individuals with binge type ED (BN-BP, AN-BP, BED), on the other hand, have high reward sensitivity especially to food cues which activate the reward system and alternate cognitive inhibitory mechanism, which may be the reason why individuals with binge-type ED have difficulties to reject food (Giel, Teufel, Junne, Zipfel & Schag, 2017).

EDs are often with chronic path, posing a significant risk for one's health and therefore often need a treatment in inpatient settings especially if individuals with ED manifest high resistance towards treatment, rapid or persistent decline in food intake, a decrease in weight despite of outpatient treatment or presence of additional stressors or comorbid psychiatric disorders that may interfere outpatient interventions. During inpatient treatment, intervention common to all the individuals with ED is the restoration of regular eating pattern (Yager et al., 2010).

Inhibitory control in individuals with ED

Inhibitory control which refers to the ability to "suppress, interrupt, or delay an activated behaviour or cognitive course of action" can be divided into two functionally different constructs: behavioural inhibition and cognitive inhibition (also known as cognitive control) (Bari & Robbins, 2013). Behavioural inhibition refers to 1) an inhibitory response process that controls overt behaviour including the ability to postpone, withhold and cancel an ongoing action 2) an ability to delay gratification and 3) an ability to manage reversal learning (Bari & Robbins, 2013). Thus, according to Bari & Robbins (2013) behavioural inhibition is a physical response whereas cognitive inhibition refers to mental processes such as inhibition of memories, thoughts, perceptions, emotions, and attention. Lawrence and colleagues (2009) have suggested that impulsivity is a consequence of inhibitory control deficits, being at the same time one of the main components of executive function (Aron, Robbins & Poldrack ,

2004). Impaired inhibitory control to food and to body related stimuli are both suggested to play an important role in the etiology and maintenance of EDs (Smith, Mason, Johnson, Lavender & Wonderlich, 2018), therefore being an essential field to study in relation to EDs.

Impaired inhibitory control is found to be especially characteristic to individuals with binge-type ED manifesting in impulsivity and loss of control during food intake, as well as in general daily behaviour (alcohol abuse, sexual disinhibition, bullying, etc.) (Wu, Hartmann, Skunde, Herzog, & Friederich, 2013). This could be explained by impulsive individuals with ED searching for immediate gratification and having difficulties inhibiting their responses (Nederkoorn, Jansen, Mulkens & Jansen, 2007) which suggests that individuals with binge-type ED indeed are more impulsive to food than to neutral stimuli. Individuals with AN-R, on the other hand, are suggested to have lower impulsivity than individuals with BN-BP, however, individuals with AN-BP are suggested to have more in common with individuals with BN-BP than with AN-R (Claes, Nederkoorn, Vendereycken, Guerrieri & Vertommen, 2006).

Self-reported versus behaviourally measured impulsivity in individuals with ED

In addition to the distinction of behavioural inhibition versus cognitive inhibition mentioned above, it is essential to differentiate inhibitory control measured by behavioural tasks (usually measured by Go/No-Go task, Dot-probe paradigm, Stop-Signal task or Stroop task) from self-reported impulsivity (e.g Barratt Impulsiveness Scale, Eysenck Impulsiveness Questionnaires etc) as impulsivity is a multifaceted construct and different instruments might assess different facets. It is also important to acknowledge that these different facets might not correlate with each other (although they both measure impulsivity) as they are different in nature (Claes et al. 2006). According to self-reported measures of impulsivity, individuals with binge-type ED are reported to be higher in motor and non-planning impulsivity (measured by BIS-11), as well as they have demonstrated higher scores in personality traits of impulsivity than restrictive type EDs (Claes et al. 2006). In addition, binge-type EDs are reported to exhibit high levels of negative urgency, which is also considered to have one of the most important impulsivity facets related to bulimic symptoms (Anestis, Smith, Fink & Joiner, 2009) and therefore also show higher scores compared to AN-R. However, it has been suggested that differences in self-reported impulsivity tend to disappear when using the behavioural tasks of impulsivity (Claes et al. 2006). Phillipou and colleagues (2016) have found that individuals with AN-R exhibit higher levels of self-reported attentional impulsivity (subscale of BIS-11) scores than HCs, however there were no differences in behaviourally

measured impulsivity in continuous performance test. It has been proposed that self-report measures of impulsivity are at odds with the behavioural data because of the lack of self-awareness (Claes et al. 2006) and perfectionistic response style (Phillipou et al. 2016) in individuals with AN-R compared to HCs.

Attentional bias and EDs

Meanwhile behavioural inhibition manifests in motor response (Bari & Robbins, 2013), attentional bias is a cognitive process described as a tendency to selectively pay attention to disorder-relevant information that is usually emotionally loaded (Williamson, White & York-Crowe, 2004). It has been suggested that emotional disorder-relevant stimuli compete with other stimuli for attentional resources (Fadardi & Cox, 2005).

Vitousek and Hollon (1990) have suggested that attentional bias in EDs is essential field of study as biases represent underlying schemata held by individuals with ED. Previous studies in the field of attentional bias have shown slightly different findings. Firstly, it has been suggested that individuals with ED have attentional bias to body-related stimuli manifesting in speeded detection of body stimuli as individuals with ED perceive body stimuli as threatening and anxiety-provoking (Smeets, Roefs, van Furth & Jansen, 2008) since they suffer from intense body concerns (Cash & Deagle, 1997). In addition, it has been suggested that individuals with BN-BP have attentional bias to food-and body-related stimuli (Brooks, Prince, Stahl, Campbell & Treasure, 2011), however, the evidence of body-related attentional bias is more robust (Albery et al., 2016). In contrast, some authors have indicated that food-related stimuli elicit cravings in individuals with binge-type ED, meanwhile faster appetitive response in the brain is related to dopamine release (Brooks et al. 2011). Furthermore, in Go/No-Go task individuals with binge-type ED tend to have quicker RTs to food stimuli compared to any other stimuli (Wu et al. 2013). Moreover, individuals with AN-R have been reported to have attentional bias only to body-related stimuli (Albery et al. 2016; Dobson & Dozois, 2004). It has been discussed that in individuals with AN-R body shape and size are the centre of concern, meanwhile food-related stimuli in individuals with AN-R might be associated with high restraint, manifesting in rather attentional avoidance of food stimuli (Dobson & Dozois, 2004; Albery et al., 2016).

Moreover, Guerrieri and colleagues (2008) have proposed that increased problems in inhibitory control are especially related to the domain individuals with ED want to control the most, being also consistent with Fadardi and Cox (2006) who suggested that individuals'

selective attention is likely to be paid to stimuli related to one's preoccupations. Therefore, individuals with BN-BP and AN-BP give their best to control their food intake and weight, however, high restraint moderated by high impulsivity, common to individuals with binge-type ED, leads to binge eating and purging in order to control their bodyweight, having selective attention to body- and food-related stimuli (Guerrieri, Nederkoorn & Jansen, 2008). Individuals with AN-R, on the other hand, have attentional avoidance to food-related stimuli, but not necessarily to body-related stimuli, as weight and body image are still the most important domains they want to control (Guerrieri et al. 2008).

As mentioned above, the findings of previous studies are mixed. For example, Johansson and colleagues (2008) have suggested, in contrast to other studies, that individuals with AN-R are more sensitive to food-related, whereas, BN-BP individuals to body-related stimuli. The authors have suggested that for individuals with BN-BP food-related stimuli are not as anxiety- provoking as for individuals with AN-R because individuals with BN-BP binge and compensate afterwards, meanwhile individuals with AN-R are on an extreme level of restraint (Johansson, Carlbring, Ghaderi & Andersson, 2008; Butler & Montgomery, 2005). In addition, individuals with BN-BP experience heightened dissatisfaction with their body, as they weigh more than individuals with AN-R (Cash & Deagle, 1997).

Impulsivity in relation to treatment outcome in individuals with ED

Previous studies have found that high self-reported impulsivity (Burdone-Cone, Butler, Balk & Koller, 2016; Mansour et al., 2012) and impaired inhibitory control (Nederkoorn, 2007) tend to predict poorer treatment outcome for individuals with binge-type ED, suggesting a link between impulsivity and ED recovery. Poorer outcome among individuals with BN-BP and AN-BP could be explained by the higher frequency of treatment dropout as a result of impulsive decision to quit the therapy as it gets emotionally too demanding (Peake, Limbert, & Whitehead, 2005) as well as by the higher possibility to give in to the temptation of high caloric food and binging (Nederkoorn et al., 2007), which refer to relapse. Agras and colleagues (2000) have also suggested that as inpatient treatment focuses on restoration of regular eating pattern, together with increasing weight and regular weightings, individuals may experience growing anxiety related to body shape and therefore end up quitting the treatment. Moreover, individuals with higher levels of impulsivity are not able to tolerate these emotions (Agras, Walsh, Fairburn,Wilson & Kraemer, 2000). In contrast, individuals with AN-R are considered to be highly perfectionistic so that they want

to get over with everything that is expected from them, therefore, being more prone to complete the treatment, however, perfectionism is also a difficult barrier to positive treatment outcome (Levinson et al., 2017).

Purpose of the current study and hypothesis

In our study, we aimed to use emotional Go/No-Go task to measure inhibitory control and attentional bias to ED specific stimuli as reflected in participants' reaction times (RTs), and their commission and omission errors to food and body stimuli. Moreover, our purpose was to examine the changes in participants' inhibitory control and attentional bias following inpatient treatment.

In addition, we aimed to control for the moderating effects of BMI, duration of illness, days between measurements, ED symptoms, depression, impulsivity and anxiety on inhibitory control and attentional bias. As Claes and colleagues (2006) have suggested, there are often discrepancy between self-report and behavioural data, therefore we also wanted to control weather inhibitory control measured by emotional Go/No-Go task is in concordance with self-reported measures of impulsivity.

Based on the literature of the same field, the following hypothesis were postulated:

1) Individuals with binge-type ED have more problems in inhibitory control to food and body related stimuli compared to AN-R and HCs, manifesting in faster RTs and more commission errors.
2) Individuals with AN-R have an attentional bias to body-related stimuli, while individuals with AN-BP and BN-BP both to food- and body-related stimuli at the beginning of treatment, manifesting in faster RTs to these stimuli compared to neutral stimuli.
3) Individuals with ED exhibit the maintenance of attentional bias to body stimuli after restoring regular meal patterns and food intake manifesting in speeded detection of body related stimuli compared to food and neutral stimuli, however individuals with AN-R lose their avoidance towards food manifesting in decreased RTs to food stimuli.

4) The problems in inhibitory control decrease in individuals with AN-R, BN-BP and AN-BP in relation to food stimuli after food restoration manifesting in quicker RTs and less commission errors in emotional Go/No-Go task.

Methodology

Permission of the study was obtained from the Research and Ethics Committee of the University of Tartu. Data collecting started on October 2016 and lasted until March 2019.

Participants

The sample consisted of 62 women, of those 19 were diagnosed with BN-BP, 17 with AN-R, 10 with AN-BP and 16 were HCs. Individuals with ED were recruited from the inpatient unit of Tartu University Clinics Eating Disorders Centre and HCs were recruited via university lists, public advertisements and with the help of acquaintances. There were also 5 individuals with AN-R and 1 individual with AN-BP among these 62 participants, who minimized their ED symptoms as reflected in self-report data (their scores deviating 2 SD from the other participants of the same diagnosis), who were included to the analysis of experimental data but not in the analysis where self-reported data was used. The descriptive data of these individuals are presented in Table 1.

Inclusion and exclusion criteria

The inclusion criteria for individuals with ED were either BN-BP, AN-R or AN-BP diagnosis and voluntary treatment. Participants gave their written consent (and their parents', if under-aged) and they had to fit the age range from 15 to 45. All the individuals with ED and healthy participants were age and education matched in order to avoid clear cognitive differences that could affect the results. The exclusion criteria were intellectual disability, acute psychotic episode, and involuntary hospitalization. There were also three participants (2 HCs and 1 individual with AN-R) who were clear outliers as their RTs were much slower than those of others and for that reason they were excluded from the analysis.

In the first measurement, the data of 34 individuals with BN-BP were collected, in the second measurement data of only 19 individuals with BN-BP were collected. The reasons for study dropout were the following: treatment dropout (for majority), change of the hospital unit and a simple wish not to continue in the study. Descriptive statistics of these 19 individuals with BN-BP who completed the study as well as of these 15 individuals with BN-

BP who dropped out are presented in Table 1 in Supplementary material. There were also 6 individuals with AN-R, 1 individual with AN-BP and 3 HCs who did not complete the second measurement, however among these individuals a clear pattern for study dropout was not established.

Procedure

Written informed consent was obtained from all the participants followed by gathering information about their age, weight, height and duration of illness (considering the time they got their ED diagnosis). These procedures were followed by the completion of emotional Go/No-Go task. All the individuals with ED underwent the first measurement during the first days of hospitalization and in every case the emotional Go/No-Go task was administered an hour after breakfast. After the Go/No-Go task, MINI psychiatric interview was conducted by clinical psychologist, followed by the completion of the self-report questionnaires regarding state domain. The second measurement was conducted following the same procedure a day before the end of the hospitalization. Mean time interval between two measurements in individuals with ED and HCs are presented in Table 1.

Measures

The Mini-International Neuropsychiatric Interview MINI 5.0.0; Sheehan, Lecrubier, Sheehan, & Amorim, 1994; Estonian version Shlik, Aluoja, & Kihl, 1999) is a diagnostic tool to diagnose DSM-IV and ICD-10 psychiatric disorders.

Barratt Impulsiveness Scale (BIS-11; Patton, Stanford & Barratt, 1995) is a 30-item self-report questionnaire, measuring the frequency of different impulsive behaviours. BIS-11 consists of three subscales measured on a 4-point Likert scale: motor impulsiveness, attentional impulsiveness and non-planning impulsiveness. Response options for items are 1) rarely/ never, 2) occasionally, 3) often, or 4) almost always (BIS-11; Patton, Stanford & Barratt, 1995).

Spielberger's State-Trait Anxiety Inventory (STAI, Spielberger & Vagg, 1984) was used to assess "state", the intensity of current feelings, and "trait", the frequency of anxious feeling in general (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). STAI is a 4-point Likert type questionnaire consisting of 40 questions from which 20 is allocated to measure trait and another 20 to measure individuals' state anxiety (Spielberger & Vagg, 1984). The response options for the state scale is 1) not at all, 2) somewhat, 3) moderately, and 4) very

much so, while for trait scale the response options are 1) almost never, 2) sometimes, 3) often, and 4) almost always (Spielberger et al.,1983).

Dickman's Impulsivity Inventory (DII) (Dickman, 1990; Estonian version Kuppart, 2005) is a self-report questionnaire consisting of 24-items, which is answered on a 5-point Likert scale. The response options are 1) totally agree, 2) agree, 3) neutral, 4) disagree, and 5) totally disagree. DII distinguishes two types of impulsivity 1) dysfunctional impulsivity (DFI) is the tendency to act less forethought than most people, and 2) functional impulsivity (FI), which is the tendency to act with little forethought although being optimal in the current situation (Dickman, 1990).

Montgomery & Åsberg Depression Rating Scale (MADRS) (Montgomery & Åsberg, 1979; Svanborg & Åsberg, 1994) is a 9-item questionnaire which is used to measure severity of depression, being the measure that detects changes in symptom severity. MADRS items are rated on a 0–6 scale (from 0, which means no abnormality, until 6 meaning severe abnormality)

Eating Disorders Assessment Scale (EDAS) (Akkermann, Herik, Aluoja, & Järv, 2010) is a 29-item questionnaire which assesses ED symptomology. There are 6 response options on 6-point Likert scale (0-never), (1-rarely), (2-sometimes), (3-often), (4-mostly), (5-always). EDAS distinguishes four ED specific behaviours 1) restrained eating, 2) binge eating, 3) purging, 4) preoccupation with body image and body weight.

Emotional Go/No-Go task (Matlab R2007b, MathWorks, Inc; DELL Latitude E6500) was used to assess inhibitory control. As in the emotional Go/No-Go task the regular word stimuli were replaced by emotional disorder-specific material (body and food pictures compared to neutral images) in addition to inhibitory control the attentional bias could be measured in individuals with ED. RTs were recorded in milliseconds (ms) and the number of commission and omission errors were registered. RTs and commission errors reflect inhibitory control management; RTs reflect attentional bias while omission errors are related to attentional difficulties (Petenberg, 2013).

Food and neutral stimuli for Go/No-Go task were obtained from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2005) and collected from personal contacts. Body pictures were taken using a voluntary female model. IAPS pictures had mean arousal index at least 5.00 with $SD < 2$. Pictures were presented for 1000 ms with 1000 ms intervals on 15.4 inch screen. All the participants received the same instruction to

press the space bar as quickly as possible when they notice the target stimulus on the screen and inhibit their response by waiting patiently the distractor stimuli to pass, when target stimulus appeared on the screen. The emotional Go/No-Go task was divided into two parts. In the first part inhibitory control was measured in relation to pictures associated to body alternated with neutral pictures (see (a) on Figure 1)), which means that in the first part of the task target and distractor stimulus was either body or neutral pictures. In the second part food pictures were alternated with neutral pictures (see (b) on Figure 1)), again both being target and distractor stimulus. When commission error was made pressing the spacebar in response to the distractor stimulus, a 2000 Hz sound signal was produced for 50 ms. Participants made two types of errors: commission errors (participant responded to the distractor stimulus) and omission errors (participant did not respond to the target stimulus (although should have responded)).

In both parts of the task, there were 15 blocks, in each one 12 stimuli from which 75% were distractors (i.e., no-go stimuli) and 25% targets (i.e., go stimuli). Before the testing phase, practice phase was conducted (which were not included in the analysis) to enable participant to learn the task before the real measurement. RTs faster than 200 ms and slower than 900 ms were considered as a missing value and were excluded from the study, because they might have been random responses. In total there were 0.5% of responses of the first and 0.3% of the second measurement excluded from the analysis.

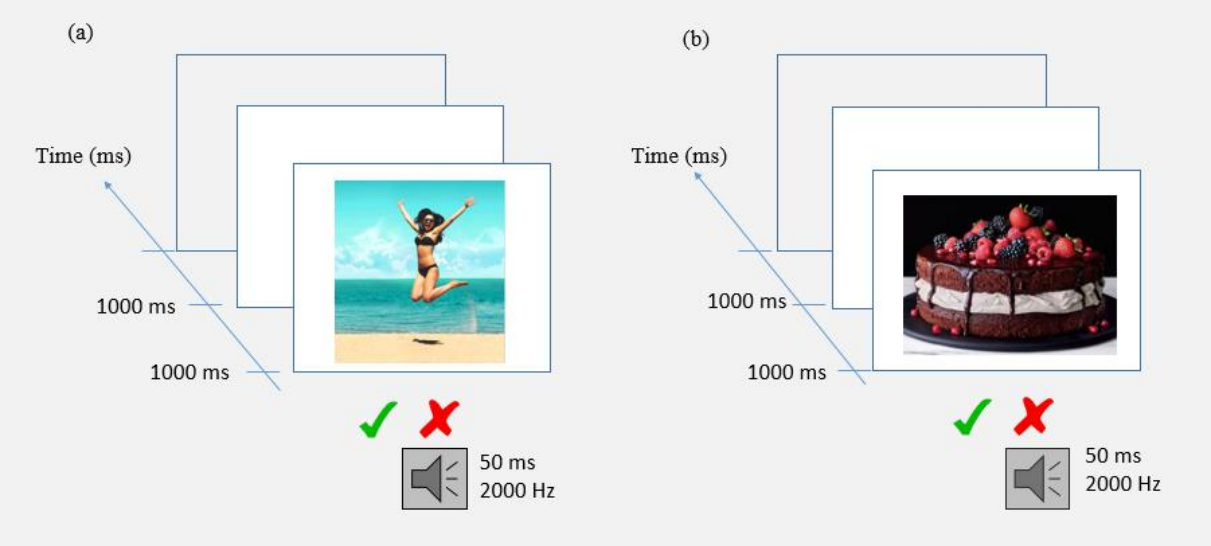

Figure 1. Screen displays of body (a) and food (b) stimuli of the emotional Go/No-Go task (pictures are illustrative)

Data analysis

Data analysis were conducted using SPSS version 20. Differences in RTs between individuals with BN-BP, AN-R, AN-BP and HCs were examined using One-Way ANOVA. Repeated measures ANOVA was conducted to examine differences in RTs to different stimuli within group. In addition, Chi-square test was used to compare the frequency of commission errors, omission errors and correct answers between individuals with different ED and HCs, whereas the test variable was "group" and data selection was minimized to type of answer and type of stimuli. Moreover, Chi-square test was also used to examine the changes in correct answers and errors made in the Go/No-Go task between the first and second measurement. In addition, we used ANCOVA to examine the moderating effects of duration of illness, days between measurements, BMI, depression, impulsivity, anxiety and ED symptoms on RTs to different stimuli. Moreover, to assess the changes in RTs during inpatient treatment, again repeated measures ANOVA was conducted using time (RTs of different stimuli measured at the first and at the second measurement) as a within-subject variable and ED diagnosis versus HCs as between-subject variable. In addition, duration of illness, days between measurements, BMI, depression, anxiety, impulsivity and ED symptoms were added to repeated measures ANOVA as covariates to examine the possible moderating effects on changes in inhibitory control and attentional bias during inpatient treatment. Power analyses was performed with GPower 3.1.9.2.

While there were not statistically significant differences in RTs nor in commission and omission errors to none of the stimuli between individuals with AN-R who were minimizing their symptoms compared to AN-R individuals who were not (See Table 2 and Table 3 in Supplementary material) in the analysis of behavioural data we tied these individuals. However, in moderation analysis the self-reported data of AN-R minimizing were excluded from the analysis, as this could have possibly affected the results.

Results

Demographics and self-reported data

One-way dispersion analysis was conducted to examine the differences between individuals with BN-BP, AN-R, AN-R minimizing, AN-BP and with HCs on age, duration of illness, BMI, days between measurements, MADRS, BIS-11, DFI, FI, S-STAI, T-STAI and EDAS subscales. Specific group differences were examined using Tukey post hoc tests. The results of the differences between individuals with ED and HCs as well as their overall

descriptive statistics are presented in Table 1.

In addition, we examined the changes of self-reported data during inpatient treatment. The most extensive changes in self-reported conditions were among individuals with BN-BP. The changes were also seen in individuals with AN-R and AN-BP, however in individuals with AN-BP the changes were observed only in depression and in EDAS restrained eating scores. The descriptive data of the first and second measurement, the changes during inpatient treatment within groups, as well as differences between the groups in the self-reported measures are presented in Table 2. (For the differences between first and second measurements in AN-R minimizing group see Table 4 in Supplementary material). In addition, we also examined the changes in BMI during treatment, and the results demonstrated that at the second measurement BMI remained significantly lower in individuals with AN-R and AN-BP as compared to individuals with BN-BP and HCs [$F(3)=12.84$ $p<.05$, $\eta^2=.510$], however a significant increase in their BMI during inpatient treatment was detected (see Table 2).

Table 1. *Descriptive statistics and group differences between individuals with BN-BP, AN-R, AN-R minimizing, AN-BP and HCs in age, duration of illness, BMI, days between measurements, MADRS, BIS-11, STAI, DII, and EDAS subscales.*

	BN-BP ***N*=19**	**AN-R** ***N*=12**	**AN- R Minimizing** ***N*=5**	**AN-BP** ***N*=9**	**HCs** ***N*=16**	**ANOVA**		
	M (SD)	***M (SD)***	***M (SD)***	***M (SD)***	***M (SD)***	***F***	***p***	**η²**
Age (years)	22.47 (6.39)	22.17 (5.01)	18.00 (1.87)	19.89 (4.29)	23.60 (8.13)	1.07 (4,55)	.381	.072
Duration of illness (years)	6.59 (6.16)[d]	3.70 (4.66)	1.55 (1.17)	3.67 (1.79)	0 (.00)[b]	5.68 (4,52)	.001	.304
BMI (kg/m^2)	22.06 (3.06) [a,c,e]	16.12 (1.60)[b,d]	16.14 (2.16) [b,d]	16.86 (1.39)[b,d]	21.87 (2.22)[a,c,e]	21.61 (4,56)	.0001	.607
Days between measurements	27.37 (19.62)	32.91 (22.49)	35.00 (31.46)	41.00 (31.14)	34.67 (25.23)	.524 (4,55)	.719	.037
MADRS	22.21 (8.44) [d,e]	18.92 (11.60)[d]	8.40 (6.80)[b,c]	28.11 (12.20)[d,e]	5.63 (2.85) [a,b,c]	13.50 (4,56)	.0001	.491
BIS-11	59.58 (9.26)	58.45 (13.16)	56.75 (12.63)	59.33 (10.19)	51.75 (7.66)	1.58 (4,54)	.193	.105
DFI	17.25 (8.92)	13.50 (6.20)	13.80 (10.66)	17.44 (6.78)	12.44 (4.83)	1.10 (4,56)	.364	.073
FI	21.38 (4.66)	17.50 (7.15)[d]	18.60 (10.21)	18.67 (8.28)	26.25 (7.18)[a]	3.02 (4,56)	.025	.178
S-STAI	53.63 (11.89)[d]	52.42 (14.76)[d]	41.40 (16.74)	55.89 (13.54)[d]	27.50 (5.50)[a,b,c]	14.14 (4,56)	.0001	.502
T-STAI	56.68 (6.91)[d]	57.50 (10.98)[d]	49.60 (18.38)[d]	61.11 (12.14)[d]	32.38 (7.15)[a,b,c,e]	19.39 (4,56)	.0001	.581
Restrained eating	25.74 (8.27)[d,e]	19.92 (9.95)[c,d,e]	4.00 (5.24)[a,b,c]	30.63 (6.78)[a,d,e]	8.50 (4.02)[a,b,c]	22.23 (4,55)	.0001	.618
Binge eating	27.84 (9.40) [a,c,d,e]	12.50 (9.22)[b]	6.80 (3.83)[b]	11.78 (7.92)[b]	8.19 (4.32) [b]	18.14 (4,56)	.0001	.564
Purging	11.58 (5.92)[d,e]	4.17 (6.75)[c]	0 (.00)[b,c]	16.56 (15.44)[a,d,e]	0 (.00)[b,c]	10.80 (4,56)	.0001	.436
Preoccupation	26.11 (8.76)[d,e]	17.75 (11.67)[d]	5.00 (4.12)[b,c]	26.56 (11.47)[d,e]	5.75 (6.48)[a,b,c]	15.54 (4,56)	.0001	.526
EDAS total	91.37 (19.74)[a,d,e]	54.33 (30.30)[b,c,d,e]	15.80 (7.40)[a,b,c]	79.75 (18.73)[a,d,e]	22.44 (11.46)[a,b,c]	34.27 (4,55)	.0001	.714

Notes: BN-BP-*bulimia nervosa* binging/purging, AN-R-*anorexia nervosa* restrictive, AN-R minimizing- *anorexia nervosa* restrictive who minimized their data, AN-BP-*anorexia nervosa* binging/purging, HCs-psychiatrically controlled healthy individuals; BMI-body mass index; MADRS- Montgomery and Asberg Depression Rating Scale; BIS-11- Barratt Impulsiveness Scale; Dickman´s Impulsivity Inventory, DFI – Dysfunctional impulsivity; FI – Functional impulsivity; S-STAI-State anxiety, T-STAI- Trait anxiety; EDAS – Eating Disorder Assessment Scale, Preoccupation-preoccupation over body image and body weight, [a]- statistically significant differences from AN-R (p<.05)., [b]- statistically significant differences from BN-BP (p<.05)., [c]-statistically significant differences from AN-BP (p<.05). [d]-statistically significant differences from HCs (p<.05), [e-] statistically significant differences from AN-R minimizing (p<.05).

Table 2. *Mean scores of both measurements, differences between the groups and changes in mean scores during inpatient treatment within the group*

	BN-BP ***N*=19** ***M (SD)***		**AN-R** ***N*=12** ***M (SD)***		**AN-BP** ***N*=9** ***M (SD)***		**HCs** ***N*=16** ***M (SD)***		**ANOVA I vs II measurement**		
	I measurement	**II measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**	***F***	***p***	**η²**
BMI (kg/m^2)	22.06 (3.06) [a,c]	22.35 (2.62)[a,c]	16.12 (1.60)[b,d]	17.17 (1.27)[b,d]*	16.86 (1.39)[b,d]	18.05 (2.26)[b,d]*	21.87 (2.22)[a,c]	21.87(2.22)[a,c]	12.71(3,47)	.0001	.448
MADRS	22.21 (6.39)[d]	13.00 (7.69)[d]*	18.92(11.60)[d]	12.83 (11.39)*	28.11 (12.20)[d]	21.11 (11.92)[d]*	5.63 (2.85) [a,b,c]	4.00 (2.18)[b,c]	2.82 (3,49)	.048	.148
BIS-11	59.58 (9.26)	55.39 (10.51)*	58.45 (13.16)	57.75 (13.86)	59.33 (10.19)	57.00 (8.12)	51.75 (7.66)	53.00 (7.81)	2.26 (3,47)	.094	.126
S-STAI	53.63 (11.89)[d]	41.50 (15.87)[d]*	52.42(14.76)[d]	43.92 (16.05)[d]*	55.89 (13.54)[d]	48.75 (13.34)[d]	27.50 (5.50)[a,b,c]	25.79 (3.81)[a,b,c]	1.61 (3,48)	.199	.092
T-STAI	56.68 (6.91)[d]	48.44 (9.84)[d]*	57.50(10.98)[d]	50.50 (14.74)[d]*	61.11 (12.14)[d]	54.88 (8.89)[d]	32.38 (7.15)[a,b,c]	34.79 (8.61)[a,b,c]	2.73 (3,48)	.054	.146
DFI	17.25 (8.92)	19.12 (10.13)	12.10 (5.22)	17.10 (7.55)[#]	16.88 (7.02)	13.63 (6.00)	12.44 (4.83)	12.21 (5.58)	3.05 (3,36)	.041	.203
FI	21.38 (4.66)	22.75 (4.56)	19.10(6.64)[d]	18.10 (9.27)[d]	18.75 (8.84)	21.50 (7.52)	26.00 (7.00)[a]	26.43 (6.35)[a]	.982 (3,36)	.412	.076
Restrained eating	25.74 (8.27)[d]	19.11 (9.86)[d]*	19.92 (9.95)[c,d]	14.64 (11.73)	30.63 (6.78)[a,d]	18.38 (11.78)*	8.50 (4.02)[a,b,c]	8.00 (4.91)[b]	2.67 (3,47)	.059	.145
Binge eating	27.84(9.40) [a,c,d]	13.39 (8.79)[a,c]*	12.50 (9.22)[b]	6.64 (4.01)[b]*	11.78 (7.92)[b]	5.43 (4.61)[b]	8.19 (4.32)[b]	8.53 (4.79)	8.70 (3,47)	.0001	.375
Purging	11.58 (5.92)[a,d]	4.94 (5.33)[a,d]*	4.17 (6.75)[b,c]	1.00 (2.32)[b,c]	16.56 (15.44)[a,d]	6.00 (3.42)[a,d]	0 (0)[b,c]	0.13 (.516)[b,c]	4.40 (3,48)	.008	.216
Pre-occupation	26.11 (8.76)[d]	19.39 (8.01)[d]*	17.75 (11.67)[d]	14.09 (10.06)	26.56 (11.47)[d]	21.86 (10.84)[d]	5.75 (6.48)[a,b,c]	6.20 (6.80)[b,c]	2.07 (3,47)	.117	.117
EDAS Total	91.37 (19.74)[a,d]	56.83 (26.36)[d]*	54.33 (30.30)[b,c,d]	36.45 (22.37)*	79.75 (18.73)[a,d]	51.14 (27.59)[d]*	22.44 (11.46)[a,b,c]	22.87 (13.45)[b,c]	6.30 (3,47)	.001	.287

Notes: BN-BP- *bulimia nervosa* binging/purging, AN-R- *anorexia nervosa* restrictive, AN-BP- *anorexia nervosa* binging/purging , HCs- psychiatrically controlled healthy individuals; BMI-body mass index, MADRS- Montgomery and Asberg Depression Rating Scale; BIS-11- Barratt Impulsiveness Scale; S-STAI-State anxiety, T-STAI- Trait anxiety; DFI – Dysfunctional impulsivity; FI – Functional impulsivity; EDAS – Eating Disorder Assessment Scale, Preoccupation-preoccupation with body image and body weight, [a]-statistically significant difference from AN-R (p<.05), [b]-statistically significant difference from BN-BP (p<.05), [c]- statistically significant difference from AN-BP (p<.05), [d]- statistically significant difference from HCs (p<.05), *-statistically significant differences between I and II measurement within the group (p<.05), [#]- statistically significant differences between first and second measurement within the group (p=.05).

Emotional Go/No-Go task

Reaction times

In the emotional Go/No-Go task group differences were examined for the first and for the second measurement between the groups using dispersion analysis and Tukey post hoc test. The results of ANOVA did not reveal any group differences for neither of the measurements between none of the groups for none of the stimuli. The RTs for all individuals with ED as well as for HCs at the first and second measurement when the presented stimuli were neutral or related to body or food are presented in Table 3.

We also used repeated measures ANOVA to examine the differences in RTs to different stimuli (to food and to body compared to neutral) within the group at the first and second measurement. The results of the first measurement demonstrated that individuals with AN-R have speeded detection of body stimuli compared to food and neutral stimuli [$F(2)=12.32$ $p<.05$, $\eta^2=.457$]. Despite of the fact that the results of the second measurement in individuals with AN-R still indicated speeded detection of body stimuli as compared to food and neutral stimuli [$F(2)=6.42$ $p<.05$, $\eta^2=.461$], the RTs to food stimuli [$F(1)=6.26$; $p<.05$, $\eta^2=.281$] and neutral [$F(1)=7.05$; $p<.05$, $\eta^2=.306$] stimuli had statistically significantly decreased after the restoration of regular eating pattern, suggesting changes in relationship with food in individuals with AN-R. In addition, the results of the first measurement revealed that individuals with BN-BP had differences in RTs to different type of stimuli [$F(2)=12.88$ $p<.05$, $\eta^2=.602$], manifesting in speeded response to body-and food-related stimuli compared to neutral stimuli. At the second measurement, however, individuals with BN-BP demonstrated speeded response only to body stimuli [$F(2)=25.21$ $p<.05$, $\eta^2=.783$]. Simple main effect analysis showed that individuals with BN-BP became statistically significantly quicker in RTs to body-related stimuli [$F(1)=4.38$; $p=.05$, $\eta^2=.196$] and to neutral stimuli [$F(1)=9.79$; $p<.05$, $\eta^2=.352$] at the second measurement, suggesting that their primary attentional bias towards food had changed after restoration of regular eating. Moreover, individuals with AN-BP did not demonstrate differences between different stimuli within the group [$F(2)=3.80$ $p>.05$, $\eta^2=.487$] at first measurement. However, post hoc comparisons demonstrated that individuals with AN-BP reacted significantly faster to food stimuli compared to neutral stimuli, whereas at the second measurement they showed speeded detection of food and body stimuli compared to neutral stimuli [$F(2)=11.18$ $p<.05$, $\eta^2=.736$], however there were not any significant changes in their RTs. The results of the changes in RTs in individuals with different ED diagnosis are presented

in Table 3. In addition, a power analyses was performed to assess the representativeness of the sample. We examined the effect sizes (Cohen's *f*) comparing individuals with BN-BP, AN-R, AN-BP and HCs at the first measurement in relation to food, body and neutral stimuli and the effect sizes were 0.20, 0.21 and 0.12, respectively. In addition, we examined the effect sizes for the second measurement and Cohen's *f* value for food, body and neutral stimuli were 0.15, 0.25 and 0.21, respectively.

Moreover, it is interesting that time (inpatient treatment) and group interaction effect was not statistically significant in relation to any type of stimuli, however, the effect of time and group became significant on RTs to body stimuli after controlling the interaction with trait anxiety [$F(1)=5.23$, $p<.05$, $\eta 2=.093$].

Table 3. *Differences in RTs between groups and changes in their RTs during two measurements as well as the differences between RTs within the group between the different stimuli*

	BN-BP ***N*=19** ***M (SD)***		**AN-R** ***N*=17** ***M (SD)***		**AN-BP** ***N*=10** ***M (SD)***		**HCs** ***N*=16** ***M (SD)***	
	I measurement	**II measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**
RT food	453.88[3] (76.61)	441.49[1] (60.40)	482.39[1] (57.18)	462.11[1]* (55.06)	463.70[3] (41.41)	454.82 (54.34)[3]	458.64[1] (55.26)	447.49 (42.09)[3]
RT body	451.31[3] (95.17)	414.12[2,3]* (58.53)	449.98[2,3] (56.92)	440.11[2,3] (45.25)	467.81 (54.66)	448.67[3] (60.87)	428.84[2,3] (37.85)	433.46 (40.48)[3]
RT neutral	476.15[1,2] (74.06)	448.81[1]* (58.0)	480.87[1] (44.16)	459.99[1]* (38.67)	489.14[2] (31.30)	476.03[1,2] (46.46)	471.32[1] (40.61)	463.37 (32.67)[1,2]

Notes: BN-BP- *bulimia nervosa* binging/purging, AN-R- *anorexia nervosa* restrictive, AN-BP- *anorexia nervosa* binging/purging , HCs- psychiatrically controlled healthy individuals, RT food- Reaction times to food stimuli (ms), RT body- Reaction times to body stimuli (ms), RT neutral- Reaction times to neutral stimuli (ms) *- statistically significant differences between I and II measurement within the group ($p<.05$), [1]-statistically significant difference in the RT to body stimuli within the group ($p<.05$), [2]-statistically significant difference in the RT to food stimuli within the group ($p<.05$) [3]- statistically significant difference in the RT to neutral stimuli within the group ($p<.05$).

In addition, ANCOVA was performed to control for the effect of duration of illness on RTs to different stimuli at the first and second measurement, and therefore individuals with minimizing symptoms were excluded for these analysis. The results of the first measurement revealed the effect of duration of illness on RTs to food-related stimuli [$F(1)=10.88$ $p<.05$, $\eta^2=.248$], to body- related stimuli [$F(1)=4.70$ $p<.05$, $\eta^2=.125$] as well as on RTs to neutral stimuli [$F(1)=5.81$ $p<.05$, $\eta^2=.150$], but the main effect of group remained insignificant. However, post hoc comparisons at the first measurement demonstrated an estimated difference in RTs to food-related stimuli between AN-R and BN-BP when duration of illness was

controlled for (See Table 5 in Supplementary material). We also examined moderating effects of days between measurements, BMI, depression, anxiety, impulsivity and ED symptoms on RTs of first measurement, but these did not yield any moderating effects on RTs to any type of stimuli.

The results of the second measurement demonstrated that there was also moderating effect of duration of illness on RTs to food [$F(1)=5.43$ $p<.05$, $\eta^2=.141$], to body [$F(1)=7.66$ $p<.05$, $\eta^2=.188$], and to neutral stimuli [$F(1)=5.67$ $p<.05$, $\eta^2=.147$], but the main effect of group remained insignificant. However, post hoc comparisons still indicated an estimated difference in RTs to body-related stimuli between BN-BP and AN-BP when duration of illness was controlled for. The estimated RTs to food, body and neutral stimuli in individuals with BN-BP, AN-R and AN-BP (but not in HCs) at the first and second measurement when duration of illness was controlled for are presented in Table 5 in Supplementary material.

As we examined effects of first measurement's self-reported data on RTs of the second measurement, there were no significant main effects. However, analyzing the effects of second measurement's self-reported data to second measurement's behavioural data, there was an effect of state anxiety on food [$F(1)=4.69$, $p<.05$, $\eta^2=.091$] and body related RTs [$F(1)=5.21$, $p<.05$, $\eta^2=.100$] but not on RTs to neutral stimuli [$F(1)=4.00$, $p>.05$, $\eta^2=.078$]. The main effect of group remained insignificant while state anxiety was controlled for.

Omission and commission errors

The results of the first measurement revealed in terms of errors made in the task, that individuals with BN-BP had significantly less correct responses to food stimuli [$\chi^2(3)=231.07$; $p<.05$], to body stimuli [$\chi^2(3)=236.40$; $p<.05$], and to neutral stimuli [$\chi^2(3)=505.97$; $p<.05$] compared to all the other groups. In addition, individuals with BN-BP made significantly more commission errors to body-related stimuli [$\chi^2(3)=26.00$; $p<.05$], to neutral stimuli [$\chi^2(3)=36.97$; $p<.05$], and to food stimuli [$\chi^2(3)=27.29$; $p<.05$] compared to other groups, although in post hoc comparisons there were not statistically significant differences between AN-R and BN-BP to food stimuli (see Table 4). Individuals with BN-BP made also more omission errors to food related stimuli [$\chi^2(3)=17.17$; $p<.05$], to neutral stimuli [$\chi^2(3)=27.47$; $p<.05$], and to body stimuli [$\chi^2(3)=15.87$; $p<.05$], however in post hoc comparison there were no differences between BN-BP and HCs in omission errors made to body stimuli.

The results of the second measurement indicated that individuals with BN-BP still had significantly less correct responses than other groups to all of the stimuli (see Table 4).

Moreover, the differences in commission errors to body-related stimuli ([$\chi^2(3)=5.79$; $p>.05$] and commission and omission errors to neutral stimuli ([$\chi^2(3)=27.26$; $p<.05$], [$\chi^2(3)=8.44$; $p<.05$], respectively) had decreased between the groups, nonetheless individuals with BN-BP still made significantly more commission errors to food-related stimuli [$\chi^2(3)=33.50$; $p<.05$] at the second measurement compared to other groups. The results of the specific group differences in frequency of errors at the first and second measurements are presented in Table 4.

Table 4. *Frequencies and differences in correct answers, in commission and in omission errors between the individuals with different ED and HCs and within group changes during inpatient treatment*

	BN-BP ***N*=19**		**AN-R** ***N*=17**		**AN-BP** ***N*=10**		**HCs** ***N*=16**	
	I measurement	**II Measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**	**I measurement**	**II measurement**
Neutral (%)								
Omission	1.4 [a,c,d]	0.9[d]*	0.8[b]	0.6	1.0[b]	1.0	0.5[b]	0.4[b]
Commission	1.7[a,c,d]	1.5 [d]	0.8[b]	0.7[c]	0.7[b,d]	1.4[a]	1.2[b,c]	0.5[b]*
Correct	96.9[a,c,d]	97.6 [a,c,d]	98.4[b,c,d]	98.7[b,c,d]	98.3[a,b,d]	97.7 [a,b,d]	98.4[a,b,c]	99.0[a,b,c]
Body (%)								
Omission	1.1[a,c]	0.7[c,d]	0.5[b,c]	1.2[c,d]*	0.1[a,b,d]	0.2 [a, b]	0.7[c]	0.2 [a,b]
Commission	2.6[a,c,d]	1.9[c]	1.0[b]	1.3	1.3[b,d]	2.0[b]	1.8[b,c]	1.3
Correct	96.4[a,c,d]	97.4[a,c,d]	98.5[b,c]	97.5[b,c]	98.6[a,b,d]	97.7[a,b,d]	97.5[b,c]	98.4[b,c]
Food (%)								
Omission	1.4[a,c,d]	0.8[c,d]	0.7[b]	0.9 [c,d]	0.6[b]	0.2[a,b]	0.6 [b]	0.3 [a,b]
Commission	3.1[c,d]	3.3[a,c,d]	2.5[c]	2.1[b,c]	1.4[a,b,d]	1.6 [a,b]	1.7[b,c]	1.6[b]
Correct	95.5[a,c,d]	95.8 [a,c,d]	96.9[b,c]	97.1[b,c]	98.1[a,b,d]	98.2 [a,b,d]	97.7[b,c]	98.1[b,c]

Notes: BN-BP- *bulimia nervosa* binging/purging , AN-R- *anorexia nervosa* restrictive, AN-BP- *anorexia nervosa* binging/purging ,HCs- psychiatrically controlled healthy individuals; [a]-statistically significant differences from AN-R ($p<.05$), [b]-statistically significant differences from BN-BP ($p<.05$), [c]-statistically significant differences from AN-BP ($p<.05$), [d]- statistically significant differences from HCs ($p<.05$), *-statistically significant differences between I and II measurements within the group ($p<.05$).

There was a statistically significant decrease in omission errors to neutral stimuli [$\chi^2(1)=4.05$; $p<.05$] in individuals with BN-BP between first and second measurement. Moreover, the changes were present in omission errors to body stimuli [$\chi^2(1)=3.85$; $p<.05$] in individuals with AN-R, manifesting in increase of omission errors. In addition, HCs demonstrated a statistically significant decrease in commission errors to neutral stimuli [$\chi^2(1)=6.48$; $p<.05$] and in omission errors to body stimuli [$\chi^2(1)=3.77$; $p=.05$]. The frequencies and differences in correct answers, commission and omission errors between groups and changes within groups are presented in Table 4.

Discussion

The aim of the study was to examine the changes in inhibitory control and in attentional bias in individuals with BN-BP, AN-R, AN-BP in relation to food and body stimuli as compared to neutral stimuli during restoration of regular eating in inpatient treatment. To be able to assess the changes in inhibitory control, in attentional bias and in self-reported data participants completed self-reported measures and emotional Go/No-Go task twice, at the beginning and at the end of inpatient treatment. Moderating effects of BMI, duration of illness, days between measurements, anxiety, impulsivity, depression and ED symptoms were also assessed.

The hypotheses about inhibitory control differences in individuals with different ED diagnosis and HCs (hypotheses 1) was only partially supported, because unlike the previous studies (Claes, Mitchell & Vandereycken, 2012) our results did not show statistically significant differences in RTs between different EDs and HCs, however our results enabled to compare inhibitory control deficits based on commission errors. There are also other authors who suggest that we cannot differentiate inhibitory control between individuals with ED based only on RTs using disorder-specific modified emotional Go/No-Go task, rather we should also consider as important commission errors made in the task (Aichert et al., 2012; Mobbs, Van der Linden, d´Acremont & Perroud, 2008; Claes et al., 2012). However, according to analysis of errors made in the emotional Go/No-Go task, individuals with BN-BP tended to make more commission errors to all of the stimuli, including neutral stimuli compared to other groups, suggesting that individuals with BN-BP may have inhibitory control problems in every domain in life (Robbins & Ehrman, 1992). In addition, first hypotheses was only partially supported because unlike individuals with BN-PB AN-BP made significantly less commission errors to all of the stimuli compared to individuals with BN-BP showing possibly the tendency to be rather similar to individuals with AN-R than to BN-BP in terms of inhibitory control, which also supports the finding of Claes and colleagues (2006). Moreover, individuals with AN-R had more commission errors to food-related stimuli, compared to individuals with AN-BP, yet not having differences with HCs, suggesting that individuals with AN-R and HCs are rather similar in their management of inhibitory control, which is also consistent with the findings of Rosval and colleagues (2006). However, our sample of individuals with AN-BP was especially small compared to individuals with BN-BP and therefore the results should be treated with caution.

Moreover, our results are in line with Mobbs and colleagues (2008) who have suggested that disorder-specific stimuli in individuals with ED capture attention more quickly than neutral stimuli. Our second hypotheses was supported, being also consistent with previous studies (Albery et al., 2016; Dobson & Dozois, 2004; Mobbs et al., 2008) suggesting that individuals with BN-BP and AN-BP have an attentional bias to food-and body- related stimuli before the inpatient treatment, manifesting in vigilance to both food and body stimuli compared to neutral stimuli. In addition, according to our results individuals with AN-R have attentional bias to body stimuli and not to food stimuli at the first measurement, manifesting in speeded detection of the body stimuli compared to neutral stimuli. Moreover, our findings are consistent with Mann and colleagues (2018) who have suggested that individuals with AN-R exhibit attentional avoidance of food stimuli, as a possible coping strategy to overcome the drive to eat. This enhanced executive ability common to individuals with AN-R to avoid food cues is also related to their ability to inhibit incentive motivational drives (Kaye, Wierenga, Bailer, Simmons & Bischoff-Grethe, 2013). Albery and colleagues (2016) have also suggested that starving within AN-R individuals may manifest in body-related attentional biases, whereas binge-type EDs have trauma associated with purging, which may be related to the amount of food that has been binged before purge episode.

There were not differences in RTs to none of the stimuli at the first nor at the second measurement between the groups. Although, the results demonstrated that after restoration of regular food intake attentional bias in individuals with AN-R remained to body-related stimuli, they lost the avoidance behaviour towards food-related stimuli, as their RTs to food stimuli had significantly decreased. In addition their inhibitory control had improved in response to food stimuli as their RTs to food-related stimuli have become significantly faster, which is in line with Kertzman and colleagues (2008), who have suggested that faster RTs in the emotional Go/No-Go task at the second measurement demonstrate improvement in inhibitory control as the response conflict has become easier to resolve. Overcoming a response conflict is which we suggest could have been possibly the case in changes to neutral stimuli as well, as individuals with AN-R managed to disengage attention from preceding disorder-specific stimuli and respond faster to neutral stimuli. Moreover, in addition to improvement in inhibitory control to body-related stimuli, manifesting in faster response and less commission errors made to body stimuli, individuals with BN-BP showed the same pattern to changes in neutral stimuli as individuals with AN-R, also referring to overcoming a response conflict. Instead of improvement of inhibitory control, individuals with BN-BP demonstrated maintenance of

attentional bias, manifesting in even quicker response at the second measurement to body stimuli, which we suggest could be the consequence of the decrease of attentional avoidance (as also seen in case of AN-R's RTs to food stimuli) as they have realized that after restoration of regular meal pattern in inpatient treatment their body weight do not increase and they have improved their concerns over body, as also reflected in preoccupation with body and weight scores. Moreover, individuals with AN-BP seemed to have similar pattern in attentional bias to individuals with BN-BP at first measurement, however they did not exhibit significant changes in their RTs nor in commission errors, however commission errors to all of the stimuli had slightly decreased becoming even with HCs at the second measurement. Stemming from previous, our third hypotheses about the maintenance of attentional bias to body-related stimuli in individuals with ED was supported. Besides, the results of the study suggest that difficulties in inhibitory control have decreased in individuals with BN-BP to body-related stimuli and in individuals with AN-R to food stimuli due to restoration of regular eating pattern, which only partially support our fourth hypotheses. Moreover, there were no differences in HCs between the two measurements, suggesting that the changes in individuals with AN-R and BN-BP were not random, but rather a consequence of restoration of regular food pattern in inpatient treatment, due to which the relationship with food had improved in individuals with BN-BP and AN-R; but in contrast body vigilance had remained in individuals with AN-R possibly because their BMI had increased and in individuals with BN-BP as they could have possibly overcome their concern over weight gain due to regular eating.

As far as self-reported measures are concerned, there were many changes in self-reported data at the second measurement compared to the first measurement in individuals with ED. All the individuals with ED exhibited decrease in depression and ED symptoms meanwhile only the individuals with BN-BP managed to benefit from the intervention as a matter of BIS-11 impulsivity scores. However, there were not statistically significant differences in BIS-11 impulsivity scores between individuals with different ED at first measurement, therefore we suggest that as caloric intake is bigger in individuals with BN-BP than in individuals with other ED before the treatment, after normalized eating pattern they might consider themselves as less impulsive in self-reported data as their binge episodes have decreased. Moreover, BIS-11 scores did not demonstrate any moderating effects on our behavioural task, which is interesting as BIS-11 has been suggested to be a questionnaire that have the highest correlation with measurements of inhibitory control (Aichert et al., 2012); and therefore it cannot be concluded that our self-reported data of impulsivity was in concordance with the data of behavioural task.

Claes and colleagues (2006), however, have suggested that self-reported data do not always correlate with behavioural data for different reasons. As for HCs, as expected, there are no changes in HCs as they did not apply any interventions, however, individuals with AN-BP demonstrated a decrease only in restraint and depression scores, so we propose that individuals with AN-BP might have been some way more ambivalent towards interventions or they are simply more rigid to adapt to intervention. In addition, Gregertsen and colleagues (2019) have suggested that lower motivation and lower BMI at baseline, as well as AN-BP "subtype" predict treatment dropout, whereas more severe eating disorder pathology and lower motivation predict poorer outcome. Therefore, we suggest that just few changes in individuals with AN-BP self-reported conditions might be also due to low motivation. Moreover, Jones and colleagues (2015) have suggested that individuals with a binge-type ED may be more vulnerable to interpersonal issues that lead to poorer treatment outcome, which might be also important field to take into account while planning the intervention.

In addition, our results demonstrated that there was also an important role of duration of illness to emotional Go/No-Go task's RT to all of the stimuli at both measurement, manifesting in quicker RTs in individuals with BN-BP, and slower RTs in individuals with AN-R and AN-BP when duration of illness was controlled for. These findings are in line with Roberts and colleagues (2010) who have suggested that poor set-shifting, manifesting in more errors made in the task, is associated with longer duration of illness and more severe ED rituals. It has also been found that individuals with more set-shifting difficulties have higher anxiety and depression scores, as well as longer duration of illness (Roberts, Tchanturia & Treasure, 2010). So we suggest that although there were not significant differences between duration of illness in individuals with different ED, individuals with BN-BP whose duration of illness were the longest, made significantly more errors in the task compared to other groups. Therefore, it can be speculated that longer duration of illness, indeed, influences the management of inhibitory control. However, as our sample sizes were small, further research should be done in order to examine the role of illness duration to inhibitory control and attentional bias. Our findings also suggest that trait anxiety might play a role in changes in body-related RTs during time interval between two measurements, however the effect sizes were small. What is interesting, is that high trait anxiety in ED individuals at the second measurement decreased RTs to body stimuli, but in contrast HCs became slower in their RTs to body stimuli. As trait and state anxiety is highly correlated, we believe that this could be explained by the decreased state anxiety scores moderating the second measurement of body RTs. Billingsley- Marshall and colleagues (2013)

have suggested that anxiety impair the performance in tasks measuring executive functioning as in case of our ED individuals at the first measurement, however their state anxiety scores ameliorate during inpatient treatment, manifesting in quicker RTs in Go/No-Go task at the second measurement.

Implications and future directions

Based on the knowledge of inhibitory control and attentional bias, emotional Go/No-Go task could be used in clinical practice as a tool to assess impaired inhibitory control and attentional biases. In addition, early assessment of the management of inhibition mechanism may be useful to detect the further movement between different EDs. Moreover, the changes during inpatient treatment enable us to assess the effectiveness of restored food pattern in inpatient unit, turn the clinicians' attention to problematic topics that are still present after treatment, as well as to predict possible relapse. Our results suggest that duration of illness plays a role in inhibitory control management, and therefore we propose that this is an important question further research should focus on. In addition to this, trait anxiety is suggested to play a role in executive functioning (Billingsley-Marshall et al., 2013), however, there is lack of evidence of inpatient treatment effectiveness related to inhibitory control while trait anxiety is controlled for. As usually inpatient treatment in ED individuals are followed by outpatient treatment, meaning that ED treatment is a particularly long process, longitudinal research on the same topic would be beneficial to acknowledge the long-term changes in attentional bias and inhibitory control; therefore the results would give us more information about the possible trait and state features related to behavioural and cognitive control mechanisms.

Limitations

The current study has several limitations. Firstly, bigger sample sizes are needed especially in individuals with AN-BP because it was difficult to detect the changes after restoration of regular eating pattern and it could have been as well due to small sample size. In addition, it would be interesting to add individuals with BN-R to the analysis to be able to compare their inhibitory control mechanisms with other individuals with ED. Secondly, it would be reasonable to let every participant assess the stimuli presented in the study, in order to get more information about the possible individual emotionality towards stimuli. Thirdly, we supposed some of our impulsivity measures moderated inhibitory control, however, we did not find any moderating effects of impulsivity to inhibitory control, therefore we suppose that there

are some other impulsivity facets that moderate inhibitory control, such as negative urgency (Manasse et al., 2016) the construct that were not measured in our study. In addition, we suggest that motivation to treatment should be measured because this is one of the biggest reasons for treatment dropout (Vall & Wade, 2015) and it is difficult to explain the lack of changes in some of the groups.

Conclusions

The results of this study suggest that individuals with BN-BP exhibit more problems in inhibitory control as compared to individuals with AN-R, AN-BP and HCs, manifesting in more commission errors made in the emotional Go/No-Go task. In addition, the results indicate that before inpatient treatment individuals with BN-BP and AN-BP have an attentional bias towards body and food stimuli and individuals with AN-R towards body stimuli, manifesting in speeded detection of these stimuli compared to neutral stimuli. However, after restored food pattern in inpatient treatment inhibitory control in individuals with AN-R improve to food-related stimuli and in BN-BP to body stimuli as RTs become faster and commission errors closer to HCs, however attentional bias remains to body stimuli in all the ED individuals, as body is their main centre of concern. Moreover, our study did not demonstrate moderating effects of self-reported impulsivity to inhibitory control, nonetheless we discovered that duration of illness has an effect to RTs to different stimuli, as well as trait anxiety is a significant moderator of changes in RTs to body stimuli.

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Supplementary material

Table 1. *Descriptive statistics and differences between individuals with BN-BP who quitted and completed the study*

	BN-BP Quitted ***N*=15** ***M(SD)***	**BN-BP Completed** ***N*=19** ***M(SD)***	**ANOVA** ***t***	***p***	***d***
S-STAI	46.73 (15.46)	53.63 (11.89)	-1.43	.166	.50
T-STAI	54.60 (13.96)	56.60 (6.91)	-.570	.603	.18
BIS-11	66.53 (12.14)	59.58 (9.26)	1.83	.078	.64
DFI	**22.60 (8.92)[a]**	**15.89 (7.10)[b]**	2.38	.025	.83
FI	23.40 (8.83)	20.37 (6.74)	1.10	.281	.39
MADRS	19.27 (13.68)	22.21 (8.44)	-.731	.473	.26
Restrained eating	24.00 (10.41)	25.74 (8.27)	-.528	.602	.19
Purging	11.60 (6.16)	11.58 (5.92)	.010	.992	.003
Preoccupation	25.60 (11.61)	26.11 (8.76)	-.140	.890	.04
Binge eating	25.20 (11.42)	27.84 (9.40)	-.723	.476	.25
EDAS total	86.40 (29.31)	91.37 (19.74)	-.563	.579	.20

Notes: BN-BP quitted- individuals with *bulimia nervosa* binging/purging who dropped out the study before the second measurement, BN-BP completed- individuals with *bulimia nervosa* binging/purging who completed the whole study, S-STAI- STAI state anxiety score, T-STAI- STAI trait anxiety score, BIS-11- Barratt Impulsiveness Scale, DFI- Dickman's Impulsivity Inventory dysfunctional impulsivity scale, FI- Dickman's Impulsivity Inventory functional impulsivity scale, MADRS- Montgomery and Asberg Depression Rating Scale; EDAS – Eating Disorder Assessment Scale, Preoccupation-preoccupation over body image and body weigh; [a]-stat significant differences from the BN-BP individuals who completed the task ($p<.05$)., [b]-statistically significant differences from the individuals with BN-BP who quitted the task ($p<.05$).

Table 2. *Mean scores and differences between individuals with AN-R and AN-R minimizing as well as the changes within groups in RTs to different stimuli*

	AN-R ***N*=12** ***M (SD)***		**AN-R minimizing** ***N*=5** ***M (SD)***	
	I measurement	**II measurement**	**I measurement**	**II measurement**
RT to food Stimuli (ms)	488.23 (64.73)	470.85 (58.80)	468.37 (34.76)	441.15 (42.92)
RT to body stimuli (ms)	459.83 (59.53)	443.64 (46.68)	426.32 (47.16)	431.64 (45.55)
RT to neutral stimuli (ms)	484.68 (48.96)	460.87* (38.88)	471.72 (32.57)	457.86 (42.61)

Notes: AN-R- *anorexia nervosa* restrictive, AN-R *anorexia nervosa* restrictive who minimized their self-reported data, *-statistically significant differences between I and II measurements within the group ($p<.05$).

Table 3. *Frequency of omission errors and commission errors, differences in errors and changes in errors in individuals with AN-R and AN-R minimizing*

	AN-R *N*=12		AN-R minimizing *N*=5	
	I measurement	II measurement	I measurement	II measurement
Neutral				
Omission %	0.9	0.8[b]	0.5	0.1[a]
Commission %	0.8[b]	0.5	0.8[a]	1.2
Correct %	98.3[e]	98.7[b]	98.6[f]	98.6[f]
Body				
Omission %	0.5	1.6[b]*	0.6	0[a]
Commission %	0.9	1.1	1.4	2.0
Correct %	98.6[e]	97.3[e]	98.0[a]	98.0[a]
Food				
Omission %	0.8[b]	1[b]	0.3[a]	0.3[a]
Commission %	1.5	1.7	5.7	3.4
Correct %	97.7[e]	97.3[b]	94.0[a]	96.3[a]

*Notes:*AN-R- *anorexia nervosa* restrictive, AN-R minimizing- *anorexia nervosa* restrictive who minimized their self-reported data, [a]-statistically significant differences from AN-R (p<.05), b-statistically significant differences from AN-R minimizing (p<.05); *- statistically significant differences between I and II measurements within the group (p<.05).

Table 4. *Mean scores of both measurements, differences between the groups and changes in mean scores during inpatient treatment within the group*

	AN-R minimizing *N*=5 *M (SD)*		ANOVA I vs II measurement		
	I measurement	II measurement	*F*	*p*	η^2
BMI	16.14 (2.16)	17.36 (1.74)*	8.03 (1,4)	.047	.667
MADRS	8.40 (6.80)	10.40 (11.61)	.775 (1,4)	.430	.159
BIS-11	56.75 (12.63)	59.50 (9.47)	.525 (1,3)	.521	.149
S-STAI	41.40 (16.74)	29.20 (12.74)	2.89 (1,4)	.164	.419
T-STAI	49.60 (18.38)	39.60 (14.93)	6.02 (1,4)	.070	.601
DFI	6.67 (4.04)	8.67 (2.08)	1.33 (1,2)	.368	.400
FI	22.40 (12.77)	24.00 (14.00	1.71 (1,2)	.321	.462
Restrained eating	4.00 (5.22)	4.20 (2.68)	.007 (1,4)	.940	.002
Binge eating	6.80 (3.83)	4.80 (5.07)	5.71 (1,4)	.075	.588
Purging	.00 (.000)	.80 (1.79)	1.00 (1,4)	.374	.200
Preoccupation	5.00 (4.12)	8.40 (7.96)	1.49 (1,4)	.289	.271
EDAS Total	15.80 (7.40)	17.60 (14.84)	.11 (1,4)	.762	.026

Notes: AN-R *anorexia nervosa* restrictive who minimized their self-reported data BMI-body mass index, MADRS-Montgomery and Asberg Depression Rating Scale; BIS-11- Barratt Impulsiveness Scale, S-STAI-State anxiety, T-STAI- Trait anxiety; DFI – Dysfunctional impulsivity; FI – Functional impulsivity; EDAS – Eating Disorder Assessment Scale, Preoccupation-preoccupation with body image and body weight,*-statistically significant differences between I and II measurements within the group (p<.05).

Table 5. *Estimated RTs to different stimuli when duration of illness is controlled for and group differences between these RTs*

	BN-BP ***N*=19** ***M (SE)***		**AN-R** ***N*=12** ***M (SE)***		**AN-BP** ***N*=9** ***M (SE)***	
	I	**II**	**I**	**II**	**I**	**II**
	Measurement	**Measurement**	**Measurement**	**Measurement**	**Measurement**	**Measurement**
RT food	436.03[a]	432.91	483.68[b]	463.66	473.74	463.72
	(13.70)	(13.07)	(16.81)	(16.04)	(18.56)	(17.70)
RT body	423.26	406.07[c]	469.70	443.69	474.17	456.96[b]
	(15.60)	(13.10)	(19.14)	(16.08)	(21.13)	(17.75)
RT neutral	459.26	440.96	489.40	466.99	498.36	482.87
	(13.27)	(12.30)	(16.28)	(15.09)	(17.98)	(16.69)

Notes: BN-BP- *bulimia nervosa* binging/purging, AN-R- *anorexia nervosa* restrictive, AN-BP- *anorexia nervosa* binging/purging, SE- Standard Error, RT food- Reaction times to food stimuli (ms), RT body- Reaction times to body stimuli (ms), RT neutral- Reaction times to neutral stimuli (ms), [a]- Statistically significant differences from AN-R ($p<.05$), [b]-statistically significant differences from BN-BP ($p<.05$), [c]-statistically significant differences from AN-BP ($p<.05$).

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