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THE DEVELOPMENT OF EMOTIONAL GO/NO-GO TASK TO MEASURE BEHAVIORAL IMPULSIVITY IN EATING DISORDER PATIENTS

Master´s thesis

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Contents

Abstract

Impulsivity and emotional bias related to disorder specific stimuli could be potential targets in the treatment of eating disorders (ED). The primary goal of this study was to develop an emotional Go/No-Go task which would reflect behavioral impulsivity in ED patients and would also demonstrate attention bias to food and body related stimuli. For the purpose of this study two versions of emotional Go/No-Go task were developed.

Results with the initial version of emotional Go/No-Go task showed slower reaction times (RTs) in *bulimia nervosa* (BN) patients which were positively associated with the making of commission errors. Also in the initial version BN patients showed attention bias in body related stimuli. After the modification of the emotional Go/No-Go task which included improving the stimuli material on the basis of emotionality and adding more blocks to the task, either of the ED groups did not exhibit higher behavioral impulsivity. Patterns of correlations with other impulsivity measures indicated that the modified emotional Go/No-Go task rather captured the attention difficulties than behavioral impulsivity.

In conclusion for the measurement of behavioral impulsivity the shorter version of the task should be used with additional improvement of stimuli material to reflect specific emotional bias in ED patients to food and body related stimuli.

Keywords: eating disorders, *anorexia nervosa*, *bulimia nervosa*, Go/No-Go task, impulsivity, emotional bias, time perception

Kokkuvõte

Emotsionaalse Go/No-Go katse loomine mõõtmaks käitumuslikku impulsiivsust söömishäiretega patsientidel

Impulsiivsus ja emotsionaalne kalle söömishäiretele spetsiifiliste stiimulite suhtes võiksid olla potentsiaalsed sekkumiskohad söömishäirete ravis. Käesoleva töö peamiseks eesmärgiks oli luua emotsionaalne Go/No-Go katse, et mõõta käitumuslikku impulsiivsust ning demonstreerida emotsionaalset kallutatust toidu ja kehaga seotud stiimulite suhtes söömishäiretega patsientidel. Eesmärgist lähtuvalt loodi kaks emotsionaalse Go/No-Go katse versiooni, et mõõta käitumuslikku impulsiivsust *anorexia nervosa* (AN), *bulimia nervosa* (BN) patsientidel ja tervetel kontrollkatseisikutel.

Tulemused esialgse emotsionaalse Go/No-Go katsega peegeldasid BN patsientide oluliselt aeglasemat reaktsiooniaega (RT) ning selle positiivset seost sagedasemate distraktor stiimulitele vastamisega. Samuti viitasid esialgse emotsionaalse Go/No-Go katse tulemused BN patsientide emotsionaalsele kaldele seoses keha stiimulitega. Modifitseeritud emotsionaalne Go/No-Go katse, mida tehti pikemaks ning mille stiimulmaterjal parandati, ei eristanud ED patsiente omavahel ega tervetest kontrollkatseisikutest käitumusliku impulsiivsuse alusel. Korrelatsioonimustrid teiste impulsiivsuse mõõdikutega viitasid, et modifitseeritud emotsionaalne Go/No-Go katse peegeldas pigem tähelepanu defitsiite kui käitumuslikku impulsiivsust.

Kokkuvõttes tuleks käitumusliku impulsiivsuse mõõtmiseks kasutada lühemat versiooni emotsionaalsest Go/No-Go katsest. Selleks, et peegeledada spetsiifilist emotsionaalset kallutatust toidu ja kehaga seotud stiimulite suhtes söömishäiretega patsientidel oleks soovitatav parandada stiimulmaterjali.

Märksõnad: söömishäired, *anorexia nervosa*, *bulimia nervosa*, Go/No-Go katse, impulsiivsus, emotsionaalne kallutatus, ajataju

Introduction

Impulsivity

Impulsivity is involved in a number of psychiatric diagnoses and it can affect the occurrence, course and treatment of different disorders (Evenden, 1999). Impulsivity, defined as a tendency to react to stimuli in a rapid unplanned fashion without allowing time for complete processing of information (Kertzman et al., 2008) is prominent in multiple theories of disordered eating behaviors (Claes, Robinson, Muehlenkamp, Vendereycken, & Bijttebier, 2010).

It has been shown in a number of studies that impulsivity differentiates eating disorder (ED) patients from healthy controls and between ED subtypes themselves (Butler & Montgomery, 2005; Cassin & von Ranson, 2005; Claes, Vandereycken, & Vertommen, 2002, 2005; Claes, Nederkoorn, Vendereycken, Guerrieri, & Vertommen, 2006; Waxman, 2009). More specifically it has been found that *anorexia nervosa* (AN) restrictive subtype patients are less impulsive compared to AN and *bulimia nervosa* (BN) patients with binge/purge subtype (Claes et al., 2005). Derived from that, using an obsessive-impulsive spectrum AN restrictive subtype can be placed on an obsessive end of it, BN on the impulsive side of the continuum and AN binge/purge subtype between AN restrictive subtype and BN (Claes et al., 2005). In treatment of ED patients it has been proposed that measuring impulsivity could be beneficial for the estimation of the possibility that AN restrictive subtype patients move on to subtypes which are characterized by binge/purge behaviors (Butler & Montgomery, 2005; Vitousek & Manke, 1994). Butler & Montgomery (2005) have proposed that measuring impulsivity over time in ED patients would provide a basis for clinical interventions as impulsivity issues could be addressed without directly confronting eating behavior.

As impulsivity is a multifaceted construct (Evenden, 1999) the results of different studies differ dependent of the methods used. There is a growing body of literature describing associations between different measures of impulsivity. By comparing self-report and behavioral measures there have been contradictory findings as in some studies self-report measures correlate with behavioral measures (Aichert, et al., 2012; Bruce, Koerner, Steiger, & Young, 2003; Havik, et al., 2012; Keilp, Sackeim, & Mann, 2005) and there are also studies which indicate that these two types of measures are not reflecting the same underlying construct (Claes et al., 2006; Claes, Mitchell, & Vandereycken, 2012; Rauch, Gold, &

Schmitt, 2012; Reynolds, Ortengren, Richards, & de Wit, 2006). These contradictory findings could arise from the social desirability that self-reported measures might reflect especially, in samples with psychiatric disorders. These contradictory findings could arise from the social desirability that self-reported measures might reflect especially in samples with psychiatric disorders (Aichert, et al., 2012; Butler & Montgomery, 2005; Cassin & von Ranson, 2005; Keilp, Sackeim, & Mann, 2005; Reynolds, Ortengren, Richards, & de Wit, 2006). However behavioral measures have downsides as well as they reflect impulsivity in one certain situation and might have limited generalizability (Waxman, 2009) and frequently the reliability of behavioral measures is uncertain (Vainik, Dagher, Dubé & Fellows, 2013). For example Butler and Montgomery (2005) demonstrated that AN patients were less impulsive than healthy controls by the means of self-report measures however by using behavioral tasks they exhibited significant indications of impulsive behavior.

The most consistent associations in different impulsivity measures have been found between Barratt Impulsiveness Scale (BIS-11), Go/No-Go task (Aichert, et al., 2012; Harrison, Everitt, & Robbins, 1999; Keilp, Sackeim, & Mann, 2005; Reynolds, Ortengren, Richards, & de Wit, 2006) and tasks measuring subjective passage of time (Havik, et al., 2012; Keilp, Sackeim, & Mann, 2005). As the correlations between different impulsivity measures have been shown to be low to moderate several researchers have emphasized that in measuring impulsivity different instruments should be used as these might tap different aspects of impulsivity (Harrison, Everitt, & Robbins, 1999; Rauch, Gold, & Schmitt, 2012; Waxman, 2009).

Behavioral measures of impulsivity

Go/No-Go paradigm is related to impulsivity as the performance on the task depends on the ability to withhold a prepotent response, as impulsive individuals have inhibition difficulties they respond when it should be withheld (Perales, Verdejo-Garcia, Moya, Lozano, & Perez-Garcia, 2009). Go/No-Go task measures selective motor response inhibition which would be presented in more impulsive individuals as a higher rate of commission errors (Aichert et al., 2012; Perales et al., 2009). Studies on behavioral impulsivity have shown that individuals with expected higher level of impulsivity (e.g. pathological gamblers, polysubstance abusers, ED patients) in addition to making more commission errors also have longer reaction times (RTs) or more variability in RT on Go/No-Go task (Bruce et al., 2003; Claes, Mitchell, & Vandereycken, 2012; Kertzman et al., 2008; Mobbs, Van der Linden, d´Acremont, & Perroud, 2008; Noël, et al., 2005). The rationale of longer RT is based on

response-conflict hypothesis (Kertzman et al., 2008; Perales et al., 2009). According to Kertzman and colleagues (2008) response conflict arises when two competing pathways are simultaneously activated as it is in Go/No-Go task. For example if the activation of giving a response is made prepotent it starts to compete with the other pathway as response inhibition is required for a correct answer.

Attention bias with medium effect to food and body related stimuli in ED patients can maintain their disordered eating (Renwick, Campbell, & Schmidt, 2013). As minor potential threats in the environment are identified more likely and due to attention disengagement problems it is harder for ED patients to evaluate the degree to which real threat is posed, their anxiety in relation to this certain stimuli is maintained (Renwick, Campbell, & Schmidt, 2013). Following this the authors propose that Attentional Bias Modification Treatment (ABMT) could be a potentially beneficial for ED patients. However for the implementation of ABMT further research on attention bias to food and body related stimuli is needed. By using affective stimuli in the Go/No-Go task it would be possible to measure emotional bias and behavioral impulsivity altogether in one experiment (Gole, Köchel, Schäfer, & Schienle, 2012; Mobbs et al., 2008).

There is an important discrepancy in the research regarding emotional bias and RT. For example Mobbs et al. (2008) reported that BN patients reacted faster to emotionally salient stimuli compared to healthy controls. In contrast similar study with polysubstance abusers found opposite results as the polysubstance abusers were significantly slower compared to healthy controls when Go/No-Go task with alcohol related stimuli was used (Noël, et al., 2005). According to Mobbs et al. (2008) food and body related stimuli captures the attention of ED patients so that it is processed more efficiently and is reflected in faster RTs. In contrast Sass et al. (2010) and Koster, Crombez, Verschuere, Van Damme, & Wiersema (2006) state that emotional bias would be seen in slower RT to emotionally salient stimuli as there would be difficulties to disengage attention from such stimulus. In a study by Gole and colleagues (2012) afore posed question was researched in pathological worriers. By using an emotional Go/No-Go task with aversive and neutral stimuli their main conclusions were that pathological worriers were more sensitive to threat, engaged more rapidly with aversion and had difficulties with disengagement which in turn led to deficits in inhibitory control. So it could be assumed that emotionally threatening stimuli for ED patients would also be reflected in longer RT.

It has been proposed that impulsive choices are the consequences of acceleration of the subjective flow of time (Keilp, Sackeim & Mann, 2005; Wittmann & Paulus, 2008). According to Wittmann and Paulus (2008) time perception is based on accumulations of pulses of time and the rate of these pulses is reflected in subjective passage of time. Time interval production (TIP) task could be seen as an operationalized mean to assess subjective time as a common ground between self-report and behavioral impulsivity measures. Such a view has also empirical support as it has been shown that tasks that assess subjective time are related to self-report measures of impulsivity as well as with performance in Go/No-Go task (Havik, et al., 2012; Keilp, Sackeim, & Mann, 2005). However it is important to note that TIP tasks have more inconsistent results in measuring impulsivity as compared to self-report measures and Go/No-Go task especially in pathological samples as there might be other relevant factors that are confounding the results (Keilp, Sackeim, & Mann, 2005).

Aim of the study

- The main purpose of this study was to develop an emotional Go/No-Go task which would differentiate ED patients from healthy controls and between ED subtypes themselves on behavioral impulsivity.

- The secondary purpose of this study was to add a measure of affective bias to the emotional Go/No-Go task by using three kinds of pictorial stimuli: food or body related stimuli and pictures depicting neutral stimuli.

- Third purpose of the study was to describe correlational associations between different impulsivity measures.

Method

The whole period of data collecting lasted from November of 2010 to April 2013 with a three month interlude in July to September in 2011. Study 1 lasted from November 2010 to June 2011 and Study 2 from October 2011 to April 2013. During the interlude modifications in testing procedures were made based on the results of the first data analysis.

ED patients for the whole study were recruited from the inpatient unit in Tartu University Clinics Eating Disorders Centre. Every patient in the Eating Disorders Centre who was hospitalized voluntarily had the opportunity to participate in the study. Control group was recruited through public advertisements, university lists and personal contacts. All ED patients were tested during the first few days of hospitalization approximately an hour after breakfast. All the procedures were conducted individually with the participants in a quiet room with only one experimenter present.

All the participants gave their informed consent and were offered an individual written feedback for the behavioral tasks. Permission for the study was obtained from the Research and Ethics Committee of the University of Tartu.

Study 1

Participants

The sample consisted of 36 women, of those 12 were diagnosed with AN, 12 with BN and 12 were age and education matched healthy controls. Descriptive characteristics of the sample are presented in Table 1. There were no statistically significant differences between groups on the educational level. To diagnose ED and to exclude participants with ED or other mental disorders from the control group The Mini-International Neuropsychiatric Interview (Sheehan, Lecrubier, Sheehan, & Amorim, 1994) was used.

Procedure

After participants had given their written informed consent The Mini-International Neuropsychiatric Interview (Sheehan, Lecrubier, Sheehan, & Amorim, 1994) was conducted. Then self-report questionnaires were given to be filled out and after that behavioral impulsivity tasks were administered.

Measures

Self-report questionnaires

Barratt Impulsiveness Scale (BIS-11; Patton, Stanford & Barratt, 1995) was used to measure impulsivity. In Estonian version 27 items out of the original 31 items formed a single scale with Cronbach α=0.80 (Paaver et al., 2007). In data analyses the total score of BIS-11 was used.

The self-report version of Montgomery-Åsberg Depression Rating Scale (MÅDRS; Montgomery & Åsberg, 1979; Svanborg & Åsberg, 1994) was used to assess depression.

Dickman Impulsivity Inventory (DII; Dickman, 1990) Estonian version (Kuppart, 2005) with two subscales was used to measure functional (FI; with Cronbach α=0.86) and dysfunctional (DFI; with Cronbach α=0.82) impulsivity.

Table 1. Descriptive characteristics of eating disorder patients and control group in study 1.

	AN (N=12)	BN (N=12)	Control group (N=12)
Age	21.8 (±4.3)	24.6 (±6.0)	22.0 (±5.3)
BMI	16.0 (±1.4)[b,c]	23.1 (±4.6)[a]	21.0 (±2.5)[a]
MinBMI	15.3 (±1.0)[b,c]	21.3 (±3.1)[a]	20.1 (±2.1)[a]
MaxBMI	17.2 (±1.1)[b,c]	25.5 (±3.7)[a,c]	21.6 (±2.4)[a,b]
IDBMI	18.6 (±0.6)[b,c]	20.1 (±1.4)[a]	20.2 (±1.6)[a]
MÅDRS	13.5 (±6.6)[c]	19.3 (±10.9)[c]	6.3 (±5.3)[a,b]
DFI	14.8 (±8.6)[b]	23.0 (±5.6)[a,c]	12.3 (±6.9)[b]
FI	23.3 (±6.6)	24.7 (±5.4)	28.3 (±7.0)
BIS-11	60.3 (±13.3)	66.5 (±11.6)	56.7 (±13.6)

Note: AN- anorexia nervosa subtype; BN- bulimia nervosa subtype; BMI- body mass index; MinBMI- lowest BMI during the last year; MaxBMI- highest BMI during the last year; IDBMI- desired BMI; MÅDRS- Montgomery-Åsberg Depression Rating Scale; DFI- Dickman Impulsivity Inventory dysfunctional impulsivity subscale; FI- Dickman Impulsivity Inventory functional impulsivity subscale; BIS-11- Barratt Impulsiveness Scale; [a]-statistically significant differences from the AN; [b]- statistically significant differences from the BN patients; [c]- statistically significant differences from the control group. Statistically significant differences between the groups are given when the p-value is <0.05.

Emotional Go/No-Go task

To measure behavioral impulsivity an emotional Go/No-Go task was used (Matlab R2007b, MathWorks, Inc; DELL Latitude E6500). For the purpose of this study pictorial material was used to add an additional measure of emotional bias. Food related stimuli and neutral pictures for the emotional Go/No-Go task were obtained from the International

Affective Picture System (IAPS[1]; Lang, Bradley & Cuthbert, 2005). Body related pictures were primarily taken using a voluntary female model except for two pictures that were taken from IAPS (Lang, Bradley & Cuthbert, 2005). IAPS pictures had mean arousal index at least 5.00 with SD<2. Selection of body related pictures was based on clinical experience and experimental practice.

Pictures were presented for 1500 ms with 1000 ms intervals on 15.4 inch screen. Participants were instructed to press previously indicated button on a computer keyboard with their dominant hand as quickly as possible when target stimulus was presented and to inhibit their response when a distractor stimulus was presented. The targets and distractors were, depending on the session, either pictures related to body or food or neutral pictures. When participants pressed the button in response to the distractor stimulus, a 2000 Hz sound signal was produced for 50 ms. There were two types of mistakes: commissions when the button was pressed in response to the distractor and omissions when a response was not made when a target stimulus was presented.

The emotional Go/No-Go task was comprised of two parts. In the first part behavioral impulsivity was measured in relation to body pictures alternated with neutral pictures. In the second part food related pictures were alternated with neutral pictures. Totally there were 5 test blocks, in each of those 12 stimuli were presented from which 25% were targets (i.e., no-go stimuli) and 75% distractors (i.e., go stimuli). Of the 5 blocks the first two had the target stimulus of the same category followed by the third block where the target stimulus was changed.

RT was measured and the number of commission and omission errors was registered. Total RT and commission errors reflect behavioral impulsivity and omission errors refer to attention difficulties while RT to different types of stimuli would be reflecting attention bias.

Time interval production task

In order to measure cognitive tempo short TIP task TakeTime (.Net Framework, Stopper class, DELL Latitude E6500) was used. Instructions were to produce temporal intervals (2, 3 or 4 s presented twice in random order) by holding down a previously indicated button on a computer keyboard as long as requested on the screen. At the beginning

[1] Pictures from IAPS used in emotional Go/No-Go task: 2037, 4255, 5001, 5010, 5020, 5201, 5390, 5450, 5470, 5471, 5660, 5700, 5731, 5740, 5994, 7002, 7052, 7056, 7058, 7090, 7100, 7190, 7217, 7235, 7508, 7950, 7200, 7270, 7291, 7330, 7340, 7350, 7430, 7450, 7460, 7470, 7480, 7488.

participants had 4 trials with immediate feedback. It was made sure that there were no clocks in the room or that the participant did not have a watch. TIP task scores for participants were calculated dividing requested temporal intervals with produced time intervals so the results >1 indicated shorter produced time intervals (overestimation or subjective acceleration of time) and results <1 indicated longer produced time intervals (underestimation or subjective deceleration of time).

Study 2

Participants

The sample consisted of 34 women, of those 6 were diagnosed with AN, 18 were diagnosed with BN and 10 were education matched healthy controls. Descriptive characteristics of the sample used in the second testing period are presented in Table 2. Similarly to study 1 The Mini-International Neuropsychiatric Interview (Sheehan et al., 1994) was used to diagnose ED or other mental disorders.

Table 2. Descriptive characteristics of eating disorder patients and healthy controls in study 2.

	AN (N=6)	BN (N=18)	Control group (N=10)
Age	21.8 (±3.5)[c*]	20.7 (±4.6)[c]	18.0 (±1.2)[a*,b]
BMI	17.0 (±1.9)[b,c]	22.5 (±2.6)[a]	21.8 (±5.0)[a]
MinBMI	15.4 (±1.8)[b,c]	20.3 (±2.7)[a]	19.6 (±1.9)[a]
MaxBMI	17.9 (±1.6)[b,c]	23.6 (±2.9)[a]	21.2(±2.8)[a]
IDBMI	19.5 (±1.0)	20.7 (±2.4)	20.5 (±2.3)
MÅDRS	17.0 (±11.8)	18.9 (±9.7)[c]	6.9 (±3.8)[b]
DFI	20.0 (±7.3)[c]	16.9 (±7.5)	13.3 (±4.3)[a]
FI	15.7 (±7.0)	21.9 (±6.6)	23.4 (±10.2)
BIS-11	63.7 (±13.7)	59.8 (±9.3)[c]	50.7 (±5.5)[b]

Note: AN- anorexia nervosa subtype; BN- bulimia nervosa subtype; BMI- body mass index; MinBMI- lowest BMI during the last year; MaxBMI- highest BMI during the last year; IDBMI- desired BMI; MÅDRS- Montgomery-Åsberg Depression Rating Scale; DFI- Dickman Impulsivity Inventory dysfunctional impulsivity subscale; FI- Dickman Impulsivity Inventory functional impulsivity subscale; BIS-11- Barratt Impulsiveness Scale; [a]-statistically significant differences from the AN patients; [b]- statistically significant differences from the BN patients; [c]-statistically significant differences from the control group.[*]-statistically significant difference when equal variances are not assumed. Statistically significant differences between the groups are given when the p-value is <0.05.

Compared to study 1 AN patients had statistically significantly lower FI score in study 2 [t (16) =2.246; $p<0.05$], BN patients had significantly lower DFI score [$t(26)=2.296$; $p<0.05$] compared to BN patients in study 1. Healthy controls in study 1 were significantly older [$t(20)=2.321$; $p<0.05$] than in study 2.

Procedure

Procedural changes included using modified emotional Go/No-Go task and at the end of the testing session administering assessment of stimuli material used in the modified emotional Go/No-Go task. As in study 1 participants also completed TIP task and filled out self-report questionnaires.

Measures

Self-report questionnaires and TIP task remained the same as in study 1.

Modified emotional Go/No-Go task

The modification of emotional Go/No-Go task included adding a practice phase with nonrelated stimuli, adding blocks to make the task longer, shortening the time that the picture was presented and changing stimuli material.

The practice phase consisted of two blocks. On the first block participants were instructed to press a previously indicated button when a non-living object is presented and to withhold their response when living object is presented. On the second block go and no-go stimuli were reversed. The purpose of the practice phase was that the participants would be familiar with the task so that the results of the experiment itself would not be confounded.

In modified emotional Go/No-Go task there were 15 test blocks each of which consisted of 12 stimuli. As in study 1 proportion of distractors (75%) was greater than targets to make response inhibition more difficult. As the task was made longer by adding more blocks the time when stimuli were presented was reduced to 1000 ms. There were 2 consecutive blocks with the same target after which go and no-go stimuli were reversed.

At the end of study 1 stimuli material used in the initial emotional Go/No-Go task was assessed by 5 women between the ages 20 to 25 on a scale from 1-9 (1=picture elicits strong negative emotions; 5=picture is neutral does not elicit neither positive nor negative emotions; 9=picture elicits strong positive emotions). The mean scores for the pictures were

considerably consistent. However the standard deviations were >2. So for the modified task the selection of stimuli material was based on previous assessment by healthy adult women.

As in the original task pictures for the emotional Go/No-Go task were obtained from IAPS (Lang, Bradley & Cuthbert, 2005) and collected through personal contacts. IAPS pictures had mean arousal index at least 5.00 with SD<2. The selection of stimuli material that would be incorporated to the task was based on the stimuli assessment by 10 women with a mean age of 24.6 (SD=3.37). They rated the pictures on a scale from 1-9 (1=picture elicits strong negative emotions; 5=picture is neutral does not elicit neither positive nor negative emotions; 9=picture elicits strong positive emotions). For the assessment there were 48 neutral pictures, 24 body and 24 food pictures. Of those 24 neutral pictures (11 of those from IAPS[2]; Lang, Bradley & Cuthbert, 2005), 12 food (2 of those from IAPS[3]; Lang, Bradley & Cuthbert, 2005) and 12 body (2 of those from IAPS[4]; Lang, Bradley & Cuthbert, 2005) pictures were selected based on the mean score and standard deviation. Mean score of the selected pictures was between 4 and 7 and the standard deviation <2.

Assessment of stimuli material

Every participant filled out a stimuli assessment sheet after the completion of behavioral impulsivity tasks. For the assessment of stimuli material 4 sets of assessment booklets were assembled. Pictures used in modified emotional Go/No-Go task were given to the participants in a randomized order. Instructions were to give each picture a value on scale from 1 to 9 (1=picture elicits strong negative emotions; 5=picture is neutral does not elicit neither positive nor negative emotions; 9=picture elicits strong positive emotions) on a first impression that comes to mind.

[2] Pictures from IAPS used in modified emotional Go/No-Go task as neutral stimuli: 6150, 7002, 7010, 7041, 7050, 7059, 7060, 7090, 7190, 7235, and 7950.
[3] Pictures from IAPS used in modified emotional Go/No-Go task as food related stimuli: 7482, 7488.
[4] Pictures from IAPS used in modified emotional Go/No-Go task as body related stimuli: 2037, 4255.

Results

Study 1

Mean scores of the self-report measures for the whole sample in study 1 are presented in Table 1.

The mean RTs for the whole sample in study 1 in emotional Go/No-Go task for food, body or neutral stimuli are presented in Table 3. There were no statistically significant differences between ED patients themselves or between ED patients and healthy controls in the commission or omission errors in emotional Go/No-Go task. The mean produced time intervals in TIP task for the whole sample in study 1 are presented in Table 3.

Table 3. Mean **r**eaction times in emotional Go/No-Go task and produced time intervals in eating disorder patients and healthy controls in study 1.

	AN (N=12)	**BN (N=12)**	**Control group (N=12)**
RT-total (ms)	537.3 (±71.4)	563.6 (±75.0)[c]	501.3 (±62.9)[b]
RT for neutral stimuli (ms)	544.6 (±71.2)	576.7 (±74.9)[c]	515.2 (±65.1)[b]
RT for stimuli related to body (ms)	516.3 (±83.9)	533.3 (±81.5)[c]	472.9 (±58.5)[b]
RT for stimuli related to food (ms)	536.5 (±80.3)	544.0 (±85.9)	493.3 (±73.3)
Produced time interval	1.68 (±1.62)	1.22 (±0.51)	1.41 (±1.29)

Note: AN- anorexia nervosa subtype; BN- bulimia nervosa subtype; RT- reaction time; TIP- Time interval production task [a]-statistically significant differences from the AN patients; [b]- statistically significant differences from the BN patients; [c]- statistically significant differences from the control group. Statistically significant differences between the groups are given when the p-value is <0.05.

Variable "group" had the main effect on the total mean RT [$F(2)=5.054$; $p<0.05$] and on the mean RT when the neutral stimuli [$F(2)=5.257$; $p<0.05$] was presented. The main effect of group remained statistically significant when the MÅDRS mean scores were controlled for.

Correlations between emotional Go/No-Go task, TIP, self-report measures and BMI for the whole sample in study 1 are presented in Table 4. In addition to correlations presented in Table 4 there were also statistically significant correlations in the whole sample of study 1 between mean RT to stimuli related to food and mean produced time intervals ($r=0.36$; $p<0.05$).

Table 4. Correlations between different impulsivity measures, MÅDRS and BMI in study 1.

	Omission	**Commission**	**RT**	**TIP**	**MÅDRS**	**BIS-11**	**FI**	**DFI**	**BMI**
Omission	1								
Commission	**0.57****	1							
RT	**0.42****	0.11	1						
TIP	0.11	-0.00	0.24	1					
MÅDRS	-0.19	-0.21	-0.08	-0.21	1				
BIS-11	-0.11	-0.10	0.03	-0.13	**0.38***	1			
FI	0.27	0.27	-0.15	-0.07	-0.32	-0.09	1		
DFI	0.13	0.05	0.27	-0.15	0.31	**0.78****	-0.03	1	
BMI	-0.02	0.09	-0.14	-0.12	0.09	0.25	0.16	**0.34***	1

Note: RT- total reaction time in emotional Go/No-Go task; TIP- time interval production task; *-statistically significant when $p<0.05$; **-statistically significant when $p<0.01$

The pattern of correlations was somewhat different when AN patients, BN patients and healthy controls were analyzed separately. In addition to correlations presented in Table 4 in BN patients commission errors were significantly correlated to total RT ($r=0.68$; $p<0.05$) and RT to food ($r=0.71$; $p<0.05$) and body related stimuli ($r=0.75$; $p<0.01$). The RT to body related stimuli was also significantly correlated with correct answers ($r= -0.63$; $p<0.05$) and the highest BMI during last year ($r= -0.65$; $p<0.05$). BMI during the last year was additionally correlated with RT to neutral stimuli ($r= -0.59$; $p<0.05$) and with the total RT in emotional Go/No-Go task ($r= -0.6$; $p<0.05$).

Study 2

Results of the self-report measures for the whole sample in study 2 are presented in Table 2.

The mean RTs for the whole sample in study 2 in modified emotional Go/No-Go task when the presented stimuli were neutral, related to body or food are presented in Table 5. There were significant differences between the groups in responses. AN patients made statistically significantly more omission errors (M=3.33; SD=2.34) in emotional Go/No-Go task compared to healthy controls (M=0.3; SD=0.68) [$t(5.505)=3.101$; $p<0.05$; *equal variances not assumed*]. Also BN patients made significantly more omission errors (M=2.11; SD=2.272) compared to healthy controls (M=0.3; SD=0.68) [$t(3.141)=21.79$; $p<0.01$; *equal*

variances not assumed]. The only difference between groups in commission errors was significant between BN patients (M=7.39; SD=5.86) and healthy controls (M=1.7; SD=1.06) [t(18.93)=4.0; p<0.01; *equal variances not assumed*]. There were statistically significant differences between AN patients and healthy controls in mean SD for RT to food related stimuli [t(14)=2.225; p<0.05]. The mean produced time intervals in TIP task for the whole sample for study 2 are presented in Table 5.

Correlations between emotional Go/No-Go task, TIP, self-report measures and BMI for the whole sample in study 2 are presented in Table 6. In addition to correlations presented in Table 4 commission errors were significantly correlated with RT to food related stimuli (r= -0.44; p<0.01), body related stimuli (r= -0.52; p<0.01) and RT to neutral stimuli (r= -0.48; p<0.01). In contrast omission errors were significantly related only with RT to neutral stimuli (r=0.39; p<0.05). In addition to correlations for the whole sample in study 2 presented in Table 4 and discussed above there were somewhat different patterns of correlations when AN patients, BN patients and healthy controls were analyzed separately. In AN patients DFI score was significantly correlated with RT to body related stimuli (r= -0.81; p<0.01) and with their BMI (r=0.85; p<0.05).

Table 5. Mean reaction times in emotional Go/No-Go task and produced time intervals in eating disorder patients and healthy controls in study 2.

	AN (N=6)	**BN (N=18)**	**Control group (N=10)**
RT-total (ms)	475.5 (±57.3)	438.1 (±54.7)	444.4 (±47.2)
RT for neutral stimuli (ms)	485.5 (±57.7)	449.9 (±51.3)	451.6 (±38.5)
RT for stimuli related to body (ms)	446.33 (±62.5)	417.0 (±60.7)	433.2 (±67.9)
RT for stimuli related to food (ms)	475.4 (±66.2)	433.3 (±64.6)	439.6 (±57.5)
Produced time interval	1.5 (±0.89)	0.99 (±0.14)	0.99 (±0.15)

Note: RT- reaction time; TIP- Time interval production task [a]-statistically significant differences from the AN patients; [b]- statistically significant differences from the BN patients; [c]-statistically significant differences from the control group. Statistically significant differences between the groups are given when the p-value is <0.05.

Table 6. Correlations between different impulsivity measures, MÅDRS and BMI in study 2.

	Omission	Commission	RT	TIP	MÅDRS	BIS-11	FI	DFI	BMI
Omission	1								
Commission	-0.07	1							
RT	**0.36***	**-0.5****	1						
TIP	0.3	-0.1	0.04	1					
MÅDRS	0.18	**0.38***	-0.14	0.09	1				
BIS-11	0.17	0.16	-0.13	**0.39***	0.29	1			
FI	-0.25	-0.00	0.08	-0.03	-0.32	-0.06	1		
DFI	0.03	0.03	-0.04	0.32	0.22	**0.8****	-0.05	1	
BMI	0.03	0.16	-0.13	-0.15	0.01	-0.03	**0.53****	-0.11	1

Note: RT- total reaction time in emotional Go/No-Go task; TIP- time interval production task; *-statistically significant when $p<0.05$; **-statistically significant when $p<0.01$

Improvement of stimuli material panned out as there were only few pictures in modified emotional Go/No-Go task which indicated some inconsistencies between groups on the basis of RTs and assessments for the pictures. More specifically there was one picture related to food and one neutral picture in association to what AN patients´ RT was significantly slower compared to BN patients and healthy controls. Based on the assessments there were four pictures related to food that BN patients rated more negatively than healthy controls. In contrast one picture associated with body and one neutral picture were rated more positively by BN patients compared to healthy controls and AN patients. However the correlations between RTs and stimuli assessments were almost nonexistent. In neutral pictures there was only one picture for which RT correlated significantly with the assessments for it. Otherwise there were significant correlations only in separate groups. BN patients´ RT to one body related picture was negatively correlated with the emotional assessment for this picture ($r= -0.81$; $p<0.01$) and one neutral picture in AN group had a negative correlation between RT and assessment ($r= -0.58$; $p<0.05$).

Discussion

The main purpose of this study was to develop an emotional Go/No-Go task which would differentiate ED patients from healthy controls and between ED diagnoses themselves on the basis of behavioral impulsivity. On this rationale samples of ED patients from the inpatient unit of Eating Disorders Centre were drawn so that patients with AN and BN could be compared to each other and with healthy controls.

In accordance with previous studies (Aichert et al., 2012; Bruce et al., 2003; Claes et al., 2005; Claes, Mitchell & Vandereycken, 2012; Kertzman et al., 2008; Mobbs et al., 2009; Noël et al., 2005; Perales et al., 2009) it was expected that BN patients would exhibit higher levels of impulsivity by making more commission errors and having slower RT compared to AN patients and healthy controls. In contrast healthy controls were expected to show the fastest RT and least of commission errors of the three groups.

In the first testing period a short emotional Go/No-Go task was used to measure behavioral impulsivity. The results of RTs were quite encouraging as BN patients had slower RTs compared to healthy controls. Consistent with response conflict hypothesis (Kertzman et al., 2008; Perales et al., 2009) the slower RT in BN patients reflected the activation of two competing pathways. These two pathways used the same resource of attention and as the conflict was more difficult to solve for impulsive individuals it took them longer time for the action to be carried out.

Stemming from the above mentioned hypothesis behavioral impulsivity as an inability to withhold a prepotent response (Perales et al., 2009) was expected to be seen in commission errors as the pathway in which correct response was activated could not override the erroneous response (Kertzman et al., 2008). However the expected pattern of commission errors in different groups did not emerge. It could be assumed that the task was too short for the differentiation between groups to be evident.

Hence for the second period of testing emotional Go/No-Go task was made longer by adding additional blocks to the task. The results are in contrast with the ones from the first testing period as the differentiation on the basis of RT was not evident in results with modified emotional Go/No-Go task. However adding blocks to the task did manage to show significantly higher rate of commission errors in BN patients compared to healthy controls.

In accordance with Kertzman et al. (2008) positive correlation between commission errors and total RT in BN patients was significant in the initial Go/No-Go task. This is associated with time-accuracy tradeoff as the slowness in RT was compensated with lower accuracy in responses (Kertzman et al., 2008; Perales et al., 2009). In contrast in the modified emotional Go/No-Go task similarly to the study of Mobbs et al. (2008) there was a significant negative correlation between commission errors and total RT in the whole sample. Also individuals who were slower in modified task made more omission errors. This pattern of results could rather reflect attention difficulties (Mobbs et al., 2008). As the modified task was comprised of three times as much of blocks used in the initial task it could be too demanding on resources of attention.

The discrepancy of results for two versions of emotional Go/No-Go tasks used in this study could be attributable to different utilized attention subsystems. According to O´Connell et al. (2008) performance on Go/No-Go task depends on the ability to maintain a strong task set and response inhibition to resolve emerged response conflict. As the initial emotional Go/No-Go task was short the demands on sustained attention were minor compared to those in modified task. So it could be speculated that the initial emotional Go/No-Go task is a more direct measure of behavioral inhibition.

The rationale for using food and body related stimuli in emotional Go/No-Go task was to add an additional measure of attention bias to emotionally salient cues. As Noël et al. (2005) demonstrated with polysubstance abusers attention bias to disorder specific stimuli such as alcohol or food and body in this study could have a significant role in the maintenance of the condition. Participants in Noël et al. (2005) study exhibited slower RT in parts of the task where an emotionally salient stimulus was used. Similarly, results with the initial Go/No-Go task indicated that BN patients had significant difficulties compared to healthy controls with body related stimuli. The tendency toward slower RT in BN patients was also observable in food related stimuli however it was not significantly different compared to control group. The fact that the food related stimuli did not reflect attention bias could have been due to the stimuli material itself. Pictures for the task development were taken from IAPS (Lang, Bradley & Cuthbert, 2005) and those could have been culturally inappropriate. As the stimuli were unfamiliar these did not elicit emotions that would be related to food in everyday life.

Inhibition difficulties in the initial Go/No-Go task were also evident in BN patients as slower RT to body related stimuli was associated with less correct responses. Even though

differences in erroneous responses were not seen between different groups, lower rate of correct answers indicates difficulties in response inhibition in body related stimuli (Mobbs et al., 2008). An intriguing result was the correlation between the highest BMI during the last year and RT to body related stimuli. As the fluctuations in BMI in BN patients during the last year were twice as large compared to AN patients or healthy controls this could indicate that an unstable BMI reflects the importance of body image in BN patients.

As the assessment of stimuli material during the interlude between two studies indicated that there might have been pictures in the initial task for which emotional intensity and valence varied between individuals considerably, the assessment of stimuli material for the modified task was done prior to including those in the study. The rationale for the improvement of stimuli material was to have as neutral stimuli as possible in the task so that differences in means or variances would be a more direct measure of attention bias to food and body cues in women with ED. As a result of this improvement emotional bias to food related stimuli was only evident in AN patients. However it could be premature to state that more variable responses in AN patients are the consequences of emotional bias toward food stimuli as AN group was significantly smaller compared to other groups which could explain larger variance in the AN patients´ results. In accordance to previous studies (Gole et al., 2012; Koster et al., 2006; Noël et al., 2005; Sass et al., 2010) it was expected that RTs for emotionally threatening stimuli would be longer or there would be more variance in the RTs. In that case there should have been emotional bias evident in BN patients´ RTs as their assessment of food stimuli was significantly more negative compared to controls.

Similarly to previous studies the associations between self-report and behavioral impulsivity measures were mostly nonsignificant (Claes et al., 2006; Claes, Mitchell, & Vandereycken, 2012; Rauch, Gold, & Schmitt, 2012; Reynolds et al., 2006). In the initial Go/No-Go task there were no significant correlations with self-report measure of impulsivity. However individuals who had slower RT in food related stimuli also produced shorter time intervals. As the faster internal cognitive tempo has been associated with impulsivity (Havik et al., 2012, Keilp, Sackeim & Mann, 2005) it could be indicating to the speed-accuracy tradeoff in Go/No-Go task in disinhibited individuals (Kertzman et al., 2008; Perales et al., 2009). Specifically in AN patients production of shorter time intervals was related to fewer correct answers in emotional Go/No-Go task. Once again consistent with previous studies (Havik et al., 2012; Keilp, Scakeim & Mann, 2005) it implies that initial Go/No-Go and TIP task tap on a common aspect of impulsivity.

In a modified Go/No-Go task the only significant association between different impulsivity measures was evident in AN patients as they were much faster in responding when their dysfunctional impulsivity was higher. As a result it could be supporting previously mentioned inference that performance in the modified task could have reflected attention difficulties rather than behavioral inhibition.

Some of the discrepancies between the two versions of emotional Go/No-Go task used in this study could be attributable to differences in samples. ED patients in study 1 were according to DII more impulsive than in study 2. It has been proposed that impulsivity and prepotent response inhibition are overlapping contructs in clinical samples with higher dysfunctional impulsivity but the relation of these is not evident in healthy controls who have normal variance in impulsivity (Aichert et al., 2012). So it could be inferred that the initial Go/No-Go task reflected behavioral impulsivity better because ED patients had higher scores on DII. In study 2 healthy controls were significantly younger than AN or BN patients also they were significantly younger in comparison of the two samples used in study 1 and study 2. So it should be taken into consideration that the sample of study 1 was more consistent with the characteristic pattern of ED patients as BN patients were the oldest, their BMI was higher and their DII subscale of dysfunctional impulsivity was higher than in AN patients or healthy controls.

Conclusion

Results of this study indicate that for measuring behavioral impulsivity in ED patients a shorter form of emotional Go/No-Go task would be recommended. Even though the initial task did not indicate differences in responses in different groups the pattern of correlations suggest that there is an underlying time-accuracy tradeoff in impulsive individuals. However for further use the stimuli in the initial task should be changed so that pictures used would be rated consistently neutral by healthy controls. Current study was unable to demonstrate associations between emotional intensity and valence with performance on modified Go/No-Go task. Nevertheless the absence of this association could be due to the larger demands on attention resources rather than on behavioral inhibition.

For further research a significantly larger samples should be used to establish how sensitive the emotional Go/No-Go task is in reflecting changes in impulsivity during the treatment of ED. Also the emotional bias to affective stimuli in ED patients and healthy controls should be ascertained. Based on these facts or tendencies emotional Go/No-Go task could be used as a clinical tool to measure behavioral impulsivity over time which would inform clinicians who would benefit from interventions targeting impulsivity. In line with the idea proposed by Renwick, Campbell and Schmidt (2013) to use ABMT in ED patients emotional Go/No-Go task could also give information regarding attention bias to food and body related stimuli.

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"The Development of Emotional Go/No-Go Task to Measure Behavioral Impulsivity in Eating Disorder patients"

Supervised by Kirsti Akkermann & Kairi Kreegipuu

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