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Modified Cue Exposure for Adolescents with Binge Eating Behaviour: Study Protocol of a Randomised Pilot Trial called EXI(ea)T

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Manuscripts

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3 **1** **Modified Cue Exposure for Adolescents**
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5 **2** **with Binge Eating Behaviour:**
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7 **3** **Study Protocol of a Randomised Pilot Trial called EXI_(ea)T.**
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54 30 adolescents, bulimia nervosa, binge eating disorder
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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

32 **Abstract**

33 Introduction: Binge eating (BE) behaviour is highly prevalent in adolescents, and can
34 result in serious metabolic derangements and overweight in the long term. Weakened
35 functioning of the behavioural inhibition system is one potential pathway leading to BE.
36 Food cue exposure focusing on expectancy violation (CE_{EV}) is a short add-on
37 intervention for BE that has proven effective in adults but has never been tested in
38 adolescents. Thus, the current randomised pilot trial evaluates the feasibility of CE_{EV}
39 for adolescents and its efficacy in reducing eating in the absence of hunger (EAH) of
40 binge food items.

41 Methods and analysis: The trial will include $N = 76$ female adolescents aged between
42 13 and 20 years with a diagnosis of bulimia nervosa (BN), binge eating disorder (BED),
43 or their subthreshold forms based on the DSM-5. Participants will be randomly
44 assigned to two sessions of CE_{EV} or behavioural analysis (BA), a classical CBT-based
45 intervention. The primary endpoint is the change in EAH measured according to ad
46 libitum consumption of personally preferred binge food in a bogus taste test at post-
47 test based on the intention-to-treat (ITT) population. Key secondary endpoints are
48 changes in EAH of standardised binge food at post-test, in EAH at 3-month follow-up
49 (FU), and in food craving after induction of food cue reactivity at posttest and FU. To
50 identify further valid outcome parameters, we will assess effects of CE_{EV} compared to
51 BA on global ED psychopathology, BE frequency within the last 28 days, body weight,
52 response inhibition, and emotion regulation abilities. Treatment groups will be
53 compared using analysis of covariance (ANCOVA) with intervention as fixed factor and
54 BMI at baseline as covariate.

55 Ethics and dissemination: This clinical trial has been approved by the Ethics Review
56 Committee of the Medical Association of Rhineland-Palatinate and the Medical Faculty
57 of the Ruhr-University Bochum.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

60 **Strengths and limitations of this study**

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- The findings of EXI_(ea)T will clarify the feasibility and efficacy of cue-exposure with expectancy violation (CE_{EV}) on ad libitum food intake and binge eating (BE) frequency in a transdiagnostic adolescent sample.
 - EXI_(ea)T is informed by previous evidence in adults and youth with obesity, includes age-appropriate material, and uses an objective measure as the primary outcome.
 - EXI_(ea)T is a randomised pilot trial comparing a short innovative add-on intervention comprising two sessions of CE_{EV} to behavioural analysis (BA) of BE episodes, the gold standard intervention of cognitive behaviour therapy (CBT).
 - As a multicentre trial, EXI_(ea)T enables a generalisation of the proof-of-concept, and contributes to quality assurance in the cooperating centres.
 - Due to the short follow-up period of three months, we cannot draw any conclusions about the long-term efficacy of CE_{EV} for eating disorder psychopathology and body weight.

77

78 **Protocol version 9.0, 25/07/2022**

79 **Trial registration:** German Clinical Trials Register, DRKS00024009, 22/01/2021

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

80 INTRODUCTION

81 *Binge eating in adolescents*

82 Binge eating (BE) behaviour refers to recurrent episodes of impulsive overeating
83 accompanied by the feeling of loss of control over eating. About 18% of 16-year-old
84 adolescents reported BE as a single symptom at least sometimes, 8.5% even weekly
85 during the last year.^{1 2} BN is a core feature of both bulimia nervosa (BN) and binge
86 eating disorder (BED), which show high prevalences of 0.9% to 3% (BN) and 1.32% to
87 5% (BED) in youth with overweight.^{3 4 5} However, the majority of affected youth do not
88 seek treatment as they associate BE with shame and guilt, leading to a long illness
89 duration (8 to 14 years) and to a persistence of adverse outcomes into adulthood.^{5 6}
90 Available first-line treatments for BE-related disorders in youth are mostly based on
91 “enhanced” cognitive behaviour therapy for EDs (CBT-E).⁷ Behavioural analysis (BA)
92 of BE episodes is among the gold standard interventions within CBT-E, and focuses
93 on early symptom changes.⁸ CBT-E has been shown to be effective in achieving BE
94 abstinence in almost 50% of patients with BN, but remission rates are lower in youth
95 than in adults, e.g. 29% remitted.⁹ Initial findings for CBT-E in adolescents with BED
96 suggest that abstinence rates are comparable to those in adults, ranging between 43
97 and 61%.^{10 11} Given the higher number of early responders in CBT-E compared to
98 other therapy approaches, BA can be seen as at least partially responsible for the rapid
99 therapeutic effects.^{12 13}
100 In sum, at least 50% of youth continue to have BE episodes or certain impulsive eating
101 behaviour patterns as residual symptoms at the end of treatment. One reason for this
102 might be that the direct underlying mechanism - food-related inhibitory control deficits
103 - is rarely targeted in conventional treatment programs.

104

105 *Inhibitory control as an underlying mechanism*

106 Recent studies emphasize an association of BE with self-reported impulsivity and
107 behaviourally measured inhibitory control deficits.^{14 15} Inhibitory control is
108 conceptualised as the ability to inhibit impulsive responses in order to select a more
109 value-based functional behaviour, e.g. eating out of deliberate pleasure instead of
110 impulsivity.¹⁶ Response inhibition in general, and towards food stimuli might be
111 impaired in adults with bulimic-type EDs¹⁷, although evidence for adolescents with BE
112 is predominantly only available for non-clinical samples.^{18 19} Moreover, a recent study

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 113 revealed that adolescents with obesity and BED displayed a poorer inhibition
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6 114 performance compared to normal-weight adolescents²⁰, although the study did not
7
8 115 allow for any conclusions on stimulus specificity. Studies examining samples with
9
10 116 overweight have yielded contradictory findings: While one study reported that children
11
12 117 were less effective in food-specific response inhibition²¹, we found that adolescent
13
14 118 psychiatric inpatients showed a rather generally impaired inhibitory control irrespective
15
16 119 of ED pathology.²² Analogous to adults, it can be assumed that there is a specific
17
18 120 subgroup of youth with impulsive eating patterns and inhibitory control deficits,
19
20 121 presumably more generalised based on their current stage of development.
21
22 122 In this framework, the dual-pathway model by Hofmann and colleagues²³ postulates
23
24 123 that BE is controlled via two processes - 1. automatic, unconscious processes and 2.
25
26 124 reflexive, conscious processes. Automatic responses to food stimuli are primarily
27
28 125 associated with the rewarding component of impulsive behaviour. This appetitive
29
30 126 responding may be related to reward sensitivity and food-related inhibition deficits and
31
32 127 is based on a heightened reactivity to palatable food cues or non-food cues that signal
33
34 128 the availability of tempting food, i.e. food cue-reactivity.^{24 25} In turn, top-down processes
35
36 129 primarily involve executive functions such as emotion regulation and general inhibition
37
38 130 abilities and are designed to counteract automatic behaviour.^{26 27} A weakened reflexive
39
40 131 system can be overridden by strong impulsive reactions to appetitive food stimuli,
41
42 132 resulting in food craving and BE. Crucially, the impaired inhibitory control seems to be
43
44 133 met with a hyperresponsive reward system due to neuroadaptive changes in reward
45
46 134 circuits (see maintenance model for BE).²⁸
47
48 135 In line with the dual-process model, recent findings have highlighted the interaction
49
50 136 between emotion regulation and inhibitory control in terms of predicting BE.^{29 30} In an
51
52 137 adult sample with self-reported ED symptoms, eating expectancies mediated the
53
54 138 relationship between emotion regulation difficulties and BE, but only in individuals with
55
56 139 reward-based inhibition deficits.³⁰ Moreover, adolescents with poor self-reported
57
58 140 inhibition experienced more uncontrolled eating, but only in the case of a negative
59
60 141 mood.³¹
62
63 142 In sum, food-related inhibitory control deficits might act as an underlying perpetuating
64
65 143 mechanism of BE, but studies examining interventions to address these deficits are
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67 144 lacking. So far, research has not identified an intervention for impulsive eating

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 145 behaviour that integrates food stimuli and has proven to be superior to other
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6 146 approaches.^{10 32}

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8 147

9 148 *Inhibitory learning approach to exposure*

10
11 149 One option to improve food-related inhibitory control is food cue exposure (CE), i.e.
12
13 150 exposure to typical binge food and its stimulus characteristics, such as the taste or
14
15 151 smell of a food, while preventing food consumption. The effect of CE on BE is often
16
17 152 measured by the intake of palatable foods in laboratory paradigms, i.e. eating in the
18
19 153 absence of hunger (EAH) in line with Birch and colleagues.³³

20 154 Researcher have discussed two potential working mechanisms for CE in the area of
21
22 155 BE: habituation and inhibitory learning. Initially, CE was seen as classical extinction
23
24 156 training derived from principles of learning theory. Treatment manuals postulating
25
26 157 habituation as a rationale recommend that patients focus on their desire to eat on a
27
28 158 psychological and physiological level, while food stimuli (conditioned stimuli, CS) are
29
30 159 presented in order to reduce food cue reactivity (conditioned appetitive responses, CR)
31
32 160 via in-session habituation.³⁴ Since the 1980s, CE with habituation has mainly been
33
34 161 researched for the treatment of BN, although over the years, this intervention was
35
36 162 forgotten somewhat due to the complexity of implementing it in clinical practice.³⁵⁻³⁸

37 163 Recently, CE has been experiencing a revival in the treatment of BN and BED, with
38
39 164 inhibitory control being used as rationale.³⁹⁻⁴¹ Research in anxiety disorders suggests
40
41 165 that repeated exposure creates a new inhibitory association such that binge food then
42
43 166 also signals the non-availability of the unconditioned eating response, i.e. a new CS-
44
45 167 noUS pairing.⁴² To enhance inhibitory learning in CE, sessions should be designed so
46
47 168 as to maximize the discrepancy between the expectancy of overeating and what really
48
49 169 happens, namely no overeating.⁴³ Magson and colleagues⁴⁴ even assume that
50
51 170 habituation occurs because of inhibitory learning - if patients are exposed to food in
52
53 171 such a way that their CS-US expectancies are not violated, no habituation processes
54
55 172 will occur and they will be vulnerable to relapses. This assumption is also in line with
56
57 173 observations that habituation within and between sessions, i.e. desire to eat, is not
58
59 174 beneficially related to EAH and weight loss^{39 43 45}, whereas changes in expectancies
60
175 were found to mediate treatment success regarding EAH.⁴³ Accordingly, CE should
176
177 optimize the violation of idiographic beliefs about eating behaviour when confronted
with the relevant binge food (e.g. "If I have milk chocolate next to me when I am sitting

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 178 alone doing my homework, I have to eat the whole bar.”). In CE with expectancy
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6 179 violation (CE_{EV}), these beliefs are checked against what actually happens, i.e. the
7
8 180 feared BE does not occur, which may strengthen the inhibitory pathway (e.g. “If I have
9
10 181 milk chocolate [...], I am able to resist eating the whole bar.”). Moreover, possible
11
12 182 underlying mechanisms of change such as inhibitory control and emotion regulation
13
14 183 abilities will be altered due to their interactions with BE expectancies.²⁹⁻³¹
15 184

16 185 *Food cue exposure with expectancy violation influencing BE*

17
18 186 A recent review⁴⁴ included 16 studies that investigated CE in adults with BE, three of
19
20 187 which focused on expectancy violation.^{39 43 45} Regardless of its focus, CE significantly
21
22 188 reduced overeating expectancies, desire to eat, and EAH as measured by kcal
23
24 189 consumption during a subsequent bogus taste test (BTT).³⁹ In addition, relative to a
25
26 190 lifestyle intervention, CE_{EV} was more effective in reducing the number of BE episodes
27
28 191 and also in reducing weight from baseline to 3-month follow-up (FU) in women with
29
30 192 overweight ($d = 0.67$ and $d = 0.65$).⁴³ Moreover, EAH for exposed food decreased
31
32 193 significantly in CE_{EV} ($d = 0.35 - 0.81$)⁴⁵, but this finding did not generalize to non-
33
34 194 exposed food.⁴³ The opposite findings emerged for non-personalised exposed food
35
36 195 items.^{43 45} It can be suggested that personalised food items might better capture
37
38 196 individual learning processes and should thus be included in CE in order to achieve
39
40 197 more profound changes in food-related inhibitory control.

41
42 198 With regard to mechanisms of change, both generic and idiographic BE expectancies
43
44 199 were found to be more effectively disconfirmed in CE_{EV} , with $d = 4.12$ and $d = 9.50$,
45
46 200 compared to active control interventions.^{43 45} Moreover, in a recent within-group pilot
47
48 201 study, significant improvements in expectancies about ability to tolerate distress were
49
50 202 found after five sessions of CE_{EV} in women with BED.⁴⁶ Interestingly, expectancy
51
52 203 violations (idiographic CS-US and distress tolerance expectancies) were found prior to
53
54 204 changes in BE frequency, emphasizing their assumed potential for subsequent
55
56 205 habituation processes.^{44 46} To date, only one study has assessed self-reported
57
58 206 impulsivity: Participants were randomized to an 8-session group intervention focusing
59
60 207 on CE or a control intervention with both conditions including self-monitoring
208
209 techniques.⁴⁰ No between-group differences emerged. To the best of our knowledge,
210
211 however, no research has assessed the efficacy of CE for food-related inhibitory
control and emotion regulation.

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

211 With respect to adolescent samples, CE has only been applied in two studies to date.³⁹
212 ⁴⁷ In patients with BN aged 14 to 19 years who had not responded well to CBT, a 12-
213 session CE with habituation was effective in significantly decreasing BE and purging
214 from baseline to post-treatment and at 6-month FU.⁴⁷ Schyns and colleagues³⁹
215 compared CE_{EV} with a lifestyle intervention in a clinical sample of adolescents with
216 obesity. The main focus of the lifestyle intervention was on providing psychoeducation
217 to increase healthier eating and physical activity. Two sessions of CE_{EV} were
218 conducted and EAH was assessed as the primary endpoint, operationalised by the
219 percentage of consumed kcal in a BTT relative to the personal daily energy
220 requirement. CE_{EV} significantly reduced the ad libitum food intake of an exposed food
221 item (chocolate mousse) and of non-exposed food items compared to the control
222 condition ($d = 0.80$ and $d = 0.76$). Contrary to findings in adults, the exposure effects
223 generalised to further highly palatable food, suggesting that adolescents might learn
224 faster.³⁹ It can therefore be assumed that not all relevant food cues need to be
225 integrated into CE_{EV} sessions. However, adherence to homework exercises was poor,
226 suggesting the need for stronger guidance of CE_{EV} at home, especially in this young
227 age group.

228 To sum up, evidence in adults and in adolescents with obesity indicates medium to
229 large effect sizes regarding the improvement of EAH via ad libitum food intake, eating
230 psychopathology, and weight reduction after only two sessions of CE_{EV}. However,
231 more RCTs are needed to support this inhibitory learning approach to exposure in
232 adolescents with BE.

233

234 **STUDY AIMS AND HYPOTHESES**

235 The current pilot study, called EXI_(ea)T, targets the feasibility and efficacy of CE_{EV} for
236 adolescents with recurrent BE episodes relative to BA in a multicentre randomised trial.
237 EXI_(ea)T is an acronym for *EXIT* strategies as a way out of binge eating. Recurrent BE
238 episodes are operationalised by a diagnosis of BN, BED, or Other Specified Feeding
239 or Eating Disorder (OSFED-BN/BED).

240 Taken together, the aims of EXI_(ea)T are to investigate (1) the application of CE_{EV}
241 compared to BA in a transdiagnostic adolescent sample with BE, (2) whether CE_{EV}
242 effectively reduces EAH and food craving at post-treatment and at 3-month FU, and
243 (3) the effect of CE_{EV} on global ED pathology, number of binge episodes and weight,

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

and (4) on underlying mechanisms of change, i.e. expectancy violations. We hypothesize that CE_{EV} will be superior to BA in reducing ad libitum food intake of personally preferred exposed and non-exposed binge foods beyond physiological needs at post-test. With regard to secondary endpoints, we expect CE_{EV} to lead to a stronger decrease in ad libitum intake of standardised binge food, food craving, ED psychopathology, and BE frequency and to a stronger weight reduction at FU compared to BA. Moreover, we hypothesize that adolescents in the CE_{EV} condition will additionally benefit with respect to larger violations of BE expectancies. On an exploratory level, we will analyse potential moderating effects of food-related response inhibition and emotion regulation abilities.

254

255 **METHODS AND ANALYSIS**

256 **Patient and Public Involvement**

257 The modified CE was developed from clinical work with adolescents with EDs. To
258 ensure appropriateness of CE_{EV} for the relevant clinical group and age range, a
259 preliminary study was conducted with a student sample aged 18-25 years who
260 experienced stress-induced chocolate cravings. The results of this preliminary study
261 on treatment expectations were used to optimise the CE before inclusion of the first
262 patient.

263

264 **Study design**

265 This study is a randomized (with a 4:4 allocation ratio), controlled, double-blind
266 multicentre trial comparing CE_{EV} to BA. Recruitment, data collection, interventions and
267 data analysis are conducted in two departments of child and adolescent psychiatry and
268 psychotherapy at the University Hospital Bochum and the University Medical Center
269 Mainz.

270

271 **Participants and recruitment**

272 The following inclusion criteria are applied 1) female adolescents aged 13;00 to 20;11
273 years; 2) presence of recurrent BE episodes (at least three objective episodes within
274 the last three months with loss of control and clinically significant distress/functional
275 impairment) assessed via an expert interview (Eating Disorder Examination, EDE-II⁴⁸
276 ⁴⁹); 3) diagnosis of BN, BED or OSFED-BN/BED (BN or BED of low frequency and/or

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

277 limited duration) based on DSM-5; 4) sufficient knowledge of the German language;
278 and 5) written informed consent of the participant and the caregivers. Adolescents are
279 excluded if they show 1) severe psychopathological comorbidities (such as severe
280 depressive episodes, borderline personality disorder, substance use disorder,
281 dissociative disorders, diagnosis of non-suicidal self-injury based on DSM-5), although
282 mild to moderate comorbidities do not lead to exclusion as long as ED symptoms are
283 the core symptoms; 2) anorexia nervosa; 3) immediate need for inpatient treatment
284 due to acute suicidality or BE/purging at a high frequency; and 4) ongoing outpatient
285 treatment with a focus on ED-specific interventions (e.g. CE, mirror exposure). The
286 participants are recruited via press releases, flyers, and social media, as well as in
287 schools, and youth centres in Hamm and Mainz and the surrounding areas. In addition,
288 cooperations with counselling centres, child and adolescent psychiatrists and
289 psychotherapists, and pediatricians are used for recruitment.

290

291 **Study flow and procedure**

292 The study flow is illustrated in Fig. 1. First, subjects and their caregivers are informed
293 about the aims and procedure of the study in a telephone interview (T_0). In addition,
294 the inclusion and exclusion criteria are checked.

295

296

Please insert Figure 1 here.

297

298 At the beginning of each session, participants' most recent food intake is assessed
299 and their current levels of hunger and desire to eat are measured on a 100mm visual
300 analogue scale (VAS). At the baseline assessment (T_1), participants undertake two
301 computer-based tasks (Food Craving Task, FCT⁵⁰; Go/NoGo Task, GNG^{51 52}), before
302 their weight, height and body fat percentage are measured by bioelectrical impedance
303 analysis (BIA). Moreover, general psychopathology is assessed and the EDE-II and
304 an interview on binge food (in which participants are asked to state four personally
305 preferred binge foods) are conducted. After a short break, relevant parts of the
306 Diagnostic Interview for Mental Disorders in Children and Adolescents (Kinder-DIPS-
307 OA)⁵³ are conducted. The remaining self-rating questionnaires are completed online
308 via REDCap⁵⁴. The randomisation takes place after T_1 using a blockwise procedure
309 (block sizes of four). To ensure that assessors (experienced and trained psychologists)

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 310 are blinded, the study leaders randomize the participants. Two sessions of CE_{EV} or BA
5
6 311 follow at T₂ and T₃. Participants are requested to eat sufficiently prior to the
7
8 312 appointments but not within the last two hours before the intervention. To avoid hunger
9
10 313 during the interventions, participants are asked to eat a cereal bar 15 minutes before
11
12 314 the intervention. After CE_{EV} and BA, current levels of hunger, desire to eat, and the two
13
14 315 relevant overeating expectancies in the CE_{EV} group are assessed again. At the end of
15
16 316 the intervention sessions, participants are strongly encouraged to repeat the exercise
17
18 317 at home to increase the transferability to daily life. We look for specific favourable times
19
20 318 of day for the implementation and anticipate possible difficulties or obstacles. The
21
22 319 participants also receive an exercise booklet with general information about the
23
24 320 intervention as well as detailed instruction and protocol sheets. At the beginning of T₃,
25
26 321 these home exercises, obstacles to implementation and potential solutions are
27
28 322 discussed and participants are again encouraged to continue with the exercises at
29
30 323 home. At the end of T₃, a BTT with all four preferred binge foods is conducted.
31
32 324 At the post-assessment (T₄), the frequency of home exercises is discussed again. Next,
33
34 325 a BTT is performed with standardised non-exposed food items (milkshakes), and the
35
36 326 computer-based tasks are repeated. Binge-purge behaviours are assessed. The
37
38 327 questionnaires can be completed at home. The post-assessment is repeated at T₅ (FU)
39
40 328 three months after T₄. At T₅, the BTT is conducted with three preferred and one
41
42 329 standardised binge foods. Any outstanding questionnaires are completed on site to
43
44 330 avoid missing data. At the end of T₅, participants receive an allowance of 50€.

331 332 **Interventions**

333 Both conditions include two face-to-face sessions with a maximum duration of 70
334
335 minutes each. Following a standardised session protocol (see Supplement), the
336
337 interventions are delivered by experienced CBT therapists at each site. In the CE_{EV}
338
339 group, participants are exposed to two out of four personally preferred binge food items.
340
341 Two individual overeating expectancies are used during exposure, and if a subject has
342
343 difficulties in formulating expectancies, standardised overeating expectancies are
344
345 applied (i.e. "If I see delicious food, I won't be able to resist eating it."). Directly before
346
347 CE_{EV} and every five minutes, subjects are asked to rate their current levels of hunger,
348
349 desire to eat the exposed food, and the two relevant overeating expectancies on a
350
351 100mm VAS. The exposure ends as soon as the desire to eat has decreased by 50%

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

343 compared to the highest rating, but at the latest after 70 minutes. After the exposure,
344 two alternative, helpful expectancies are developed together with the therapist and are
345 written on two index cards so that the participant can carry them with her. Control group
346 participants undergo a BA of the last BE episode based on the SORKC model.⁵⁵ First,
347 situational and preceding factors as well as the cognitive, emotional, physiological and
348 behavioural reactions of the participant are identified. In addition, consequences of the
349 behaviour are detected. The BA ends with a solution analysis by identifying effective
350 skills to prevent BE, but also after 70 minutes at the latest.

351

352 **Diagnostic and outcome assessments**

353

354 ***Patient characteristics and diagnostics***

355 Besides sociodemographic information such as age and school type, general
356 information such as ongoing therapy, and previous treatments is gathered. In addition,
357 information to compute the socioeconomic status (SES; Winkler-Index⁵⁶) is obtained.
358 To identify possible comorbidities, the Freiburger Screening for Mental Disorders
359 (FSP)⁵⁷ is used as screening instrument. The sections on depressive disorders, anxiety
360 disorders, ADHD, conduct disorders, tic disorders, enuresis, encopresis and non-
361 suicidal self-injury disorder are administered routinely in the Kinder-DIPS-OA; the other
362 sections are explored in the case of relevant answers in the previously administered
363 FSP. Eating disorder psychopathology is assessed with the well-established interview
364 EDE-II which allows an accurate clinical judgment of global ED psychopathology over
365 the last 28 days and is considered the gold standard for ED-specific diagnostics.⁵⁸
366 Other diagnostics are general psychopathology^{59 60}, last food intake, level of hunger
367 and desire to eat. Instruments and their psychometric characteristics are illustrated in
368 Table 1.

369

3 370 **Table 1.** Assessment plan from screening (T₀) to 3-month follow-up (T₅).

Variable	Instrument	Description	Score indication	Assessment moments				
				T ₁	T ₂	T ₃	T ₄	T ₅
Diagnostics								
Eligibility screen		Inclusion and exclusion criteria		X				
Clinical baseline data		e.g. age, school type, treatments		X				
General psychopathology - self-report	Strengths and Difficulties Questionnaire (SDQ) ^{59 60}	25 items range from 0-40	Higher scores indicate more externalising and internalising problems	X				
Psychological impairment	Freiburger Screening für psychische Störungen (FSP) ⁵⁷	Screening questions for 14 mental disorders with 29 items		X				
General psychopathology - clinical judgment	Diagnostic Interview for Mental Disorders in Children and Adolescents (Kinder-DIPS-OA) ⁵³	Screening for mental disorders according to the DSM-IV-TR ⁵⁴ and ICD-10 ⁵⁵		X				
Eating disorder psychopathology - clinical judgment	Eating Disorder Examination-II (EDE-II) ^{48 49}	Semi-structured interview with 22 and four subscales "Restraint", "Eating concerns", "Shape concerns", and "Weight concerns"	Higher scores indicate more eating disorder psychopathology	X				
Primary outcome								
Eating in the absence of hunger (EAH)	Bogus Taste task (BTT, preferred food items) ⁶¹	Exposition to their personally preferred food items	Higher consumed calories indicate more EAH			X		X
Secondary outcomes								
Eating in the absence of hunger (EAH)	Bogus Taste task (BTT, standardised food items) ⁶⁶	Exposition to milkshakes	Higher consumed calories indicate more EAH				X	X
Momentary food craving	Food Challenge Task (FCT) ⁵⁰	Craving is measured with the Food Craving Questionnaire-	Higher scores indicate higher intensity of craving	X			X	X

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

		State (FCQ-S) ^{63 64} , consists of 15 items range from 15-75					
Binge eating	Eating Disorder Examination-II (EDE-II) ^{48 49}				X	X	X
Eating disorder psychopathology - self-report	Eating Disorder Examination-Questionnaire (EDE-Q) ^{65 66}	Self-report questionnaire with 22 items	Higher scores indicate more eating disorder psychopathology		X	X	X
Weight, height, body fat	Bioelectrical impedance analysis (BIA), InBody770*				X	X	X
Food craving	Food Craving Questionnaire-Trait (FCQ-T-r) ^{63 67}	15 items range from 15-90	Higher scores indicate higher frequency and intensity of food craving		X	X	X
Moderator variables							
Response inhibition	Go/NoGo Task (GNG Task) ^{51 52}	Affective shifting task with high-caloric vs. neutral food stimuli; 16 blocks with a total of 320 trials	Higher number of commission errors indicate lower inhibition skills		X	X	X
Emotion regulation	Difficulties in Emotion Regulation Scale (DERS) ^{68 69}	36 items range from 36-180	Higher scores indicate more difficulties in emotion regulation		X	X	X
Treatment expectation and evaluation							
Treatment expectation	Expectation of Improvement and Suitability of Treatment Form (EIST) ⁷⁶	Two items, rated on a 10-point Likert scale	Higher scores indicate positive treatment expectation		X	X	X
Treatment evaluation	Patient Questionnaire on Therapy Expectation and Evaluation (PATHEV) ⁷⁸	11 items, rated on a 5-point Likert scale	Higher score indicate better treatment evaluation		X	X	X

Notes. T₀ = Telephone interview; T₁ = Baseline assessment; T₂ = Intervention session 1; T₃ = Intervention session 2; T₄ = Post-assessment; T₅ = Follow-up; * Body fat is only measured at the Mainz site.

373 **Primary Outcome**

374 EAH is assessed with BTT, a valid and sensitive instrument to investigate whether
375 experimental manipulations affect food intake.⁶¹ Participants are exposed to their
376 personally preferred binge foods and are asked to evaluate the taste of the food on a
377 rating sheet. They are invited to eat as much as they need to evaluate the taste. Before
378 and after the rating, the weight of the food is measured and the consumed calories are
379 calculated. The dependent variable is the percentage of consumed calories in relation
380 to the individual's daily energy requirements with respect to age and gender in line with
381 the recommendations of the United Nations University and the World Health
382 Organization.⁶²

384 **Secondary Outcomes**

385 EAH is measured with standardized food items in the BTT. Momentary food craving is
386 assessed with the FCT in which a five-minute video with tasty foods is presented to
387 induce craving. After participants have watched the video, the experience of craving is
388 measured with the Food Craving Questionnaire-State (FCQ-S).^{63 64} The FCT has
389 proven to be valid for the standardised induction of food cue reactivity to measure
390 momentary food craving.⁵⁰ Other secondary outcome measures are binge eating,
391 eating disorder psychopathology^{65 66}, weight, height, body fat and trait food craving
392 (FCQ-T-r).^{63 67}

394 **Moderators**

395 To identify possible moderating effects, emotion regulation is measured with the
396 Difficulties in Emotion Regulation Scale (DERS)^{68 69}, and response inhibition is
397 assessed with a modified personalised GNG affective shifting task (high-calorie food
398 category vs. neutral category).^{51 52} Neutral stimuli (flower, towel) and high-calorie foods
399 (chocolate, pizza) are presented as Go or NoGo stimuli (depending on the block). To
400 determine participants' personal taste preferences, prior to the GNG Task, they are
401 asked to rate 30 high-calorie food stimuli on a 7-point Likert scale (0 = not at all
402 palatable to 6 = extremely palatable). The ten personally most palatable food stimuli
403 are then used in the task. Participants are instructed to press a button when watching
404 a relevant stimulus ("Go") and to not press the button when watching an irrelevant
405 stimulus ("NoGo"). The task consists of 16 blocks with 50% of the stimuli presented as
406 Go stimuli and 50% as NoGo stimuli in each block. Participants receive instructions at

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

the beginning of each block. Each stimulus is presented for 500ms with an inter-trial interval of 1000ms. Dependent variables are participants' reaction times and number of commission errors (false reactions to a NoGo instruction) and omission errors (missing reactions to a Go instruction). The GNG task is a widely used task to measure response inhibition.²²

Additional assessments

Adherence control

Attrition rate and study dropouts are assessed in both treatment groups. Manual adherence across the different therapists is achieved through standardised treatment protocols, online trainings and fortnightly supervisions by a licensed expert in ED treatment (TL) across both participating centres.

Treatment Expectation and Evaluation

Treatment expectation and evaluation are assessed with the Expectation of Improvement and Suitability of Treatment Form (EIST)⁷⁶ and the Patient Questionnaire on Therapy Expectation and Evaluation (PATHEV).⁷⁸

Sample size calculation

The sample size calculation is based on the publication of Schyns and colleagues³⁹, which reports an effect size of $d = 0.8$ between groups for the percentage of consumed kcal during the taste test relative to the daily energy requirements (experimental group: mean 57% ($N = 21$; $SD = 68\%$), control group: mean 146% ($N = 19$; $SD = 141\%$)). When calculating the pooled standard deviation ($SD_{pooled} = 118.5\%$) and assuming an effect size of 0.8, this results in an absolute difference of 75% in the mean between groups, which can be considered as relevant. When assuming a two-sided significance level, a power of 90%, an effect size of $d = 0.8$, and a sample size of 68 patients (=2x34 patients) will be needed to detect a significant treatment difference at post-assessment when using a t-test. As the duration of treatment is very short (two weeks only), we assume that patient loss due to non-compliance will be minimal. To account for 10% dropouts³⁹, 76 patients should be randomised. The calculation was performed using SAS Version 9.4.

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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441 **Data analysis plan**

442 Regarding the primary outcome EAH, treatment groups will be compared using an
443 analysis of covariance (ANCOVA) with intervention as fixed factor and BMI at baseline
444 as covariate. The primary analysis is performed on the ITT population consisting of all
445 patients randomised. The secondary parameters are mostly continuous parameters,
446 and will be analysed using AN(C)OVAs and t-tests. Sample characteristics will be
447 provided. A p-value of $< .05$ is considered as statistically significant (two-sided).
448 Missing values will not be replaced. There will be several sensitivity analyses, e.g. by
449 considering additional covariates.

450

451 **ETHICS AND DISSEMINATION**

452 **Ethics and safety aspects**

453 The trial will be conducted according to the principles of ICH-GCP and appropriate
454 legal regulations, and will be adhere to the Declaration of Helsinki in its latest version.
455 Participating individuals are provided with treatment as usual (TAU which consists of
456 BA) for EDs according to good clinical practice.⁷⁰ The study protocol including
457 amendments has been and will be approved by the responsible ethics committees.
458 Important protocol modifications will be reported to the German Clinical Trials Register
459 and to the journal. Participants and caregivers must provide written informed consent
460 before beginning the study. CE is generally well tolerated^{39 43}, and risks for participants
461 are not known or expected. Trained clinical staff will be available to monitor safety
462 concerns and support patients during/after treatment.

463

464 **Dissemination plan**

465 The collected data will be published in relevant scientific journals and will be presented
466 at conferences. Participants data will only be published in anonymised form.

467

468 **DISCUSSION**

469 Research on add-on treatment elements for BE in adolescents is still limited, leaving a
470 gap in knowledge on interventions that might enhance outcomes for this age group.
471 One promising way to achieve this might be to target food-related inhibitory control as

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

an underlying perpetuating mechanism of BE. Recent results suggest a successful adaptation of CE_{EV} for pathological eating behavior. However, little is known about the feasibility and efficacy of CE_{EV} for adolescents with recurrent BE episodes. Thus, the findings of $EXI_{(ea)T}$ might clarify whether CE_{EV} is accepted by a transdiagnostic adolescent sample and whether it is able to reduce the ad libitum consumption of highly palatable foods when satiated as well as ED pathology. Furthermore, we will elucidate the role of CS-US expectancy violations, response inhibition, and emotion regulation in CE_{EV} . The strengths of $EXI_{(ea)T}$ lie in the inclusion of a credible, active control condition, considered as the gold standard intervention of CBT-E to treat BE, and the use of an objective measure to assess changes, i.e. ad libitum food intake, as the primary efficacy endpoint. Moreover, the CE_{EV} treatment protocol includes the most relevant CE strategies to maximize treatment success⁴⁴, i.e. in-vivo exposure, personally preferred food cues and non-food cues (due to imagery of trigger situations at the beginning of session), occasionally eating allowed and personal CS-US expectancies identified. Additionally, to overcome poor homework adherence, we offer a detailed exercise booklet, discuss implementation problems and debrief all exercises at the beginning of session 2. On the level of limitations, it should be noted that $EXI_{(ea)T}$ cannot evaluate the efficacy of CE_{EV} as an add-on intervention to CBT-E as a whole. Moreover, there is no data monitoring committee to review accumulating data, which may affect the independence of the analyses. In addition, our decision to use the DSM-5 criteria and not the age-adapted criteria for BED^{71 72} or modified ICD-11 criteria for bulimic disorders⁷³, which emphasize the subjective loss of control (LOC), needs to be explored with respect to recruitment procedures. Indeed, we have not found prior evidence that CE_{EV} is also a valuable intervention with respect to LOC eating. However, if CE_{EV} is effective and feasible for adolescents with BE, we might conduct a confirmatory randomised trial in order to test CE_{EV} as a useful adjunct to first-line treatment.

Trial status

Recruitment for this trial started in April 2021 and is ongoing.

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 **505 Contributions**

5
6 506 All authors contributed to the design and conception of this study. HP, IK, JE and TL
7
8 507 elaborated the study protocol and gained ethical approval. HP and IK drafted the
9
10 508 manuscript and all co-authors revised the manuscript critically. All authors have read
11
12 509 and approved the final version of the article submitted.

13 510

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19
20 514 Reiss foundation. This funding had no role in the design of the study and in writing the
21
22 515 manuscript.

23 516

24
25 **517 Competing interests**

26
27 518 TL receives royalties for textbooks in the field of eating disorders from Hogrefe,
28
29 519 Kohlhammer, Springer and DeGruyter as well as funding from the German Ministry of
30
31 520 Education and Research (BMBF) for studies in the field of eating disorders and obesity.
32
33 521 HP receives royalties for a therapy manual for BE from Hogrefe. The other authors
34
35 522 declare that they have no competing interests.

36 523

37 **524 Ethics approval**

38
39 525 Ethical approval has been granted by the Ethics Review Committee of the Medical
40
41 526 Association of Rhineland-Palatinate (No. 2020-14980) and of the Medical Faculty of
42
43 527 the Ruhr-University Bochum (No. 20-7051 BR).

44 528

45 **529 Provenance and peer review**

46
47 530 Not commissioned; externally peer reviewed.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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760 FIGURE LEGEND

761 **Figure 1.** Study flow chart from screening (T₀) to 3-month-FU (T₅).

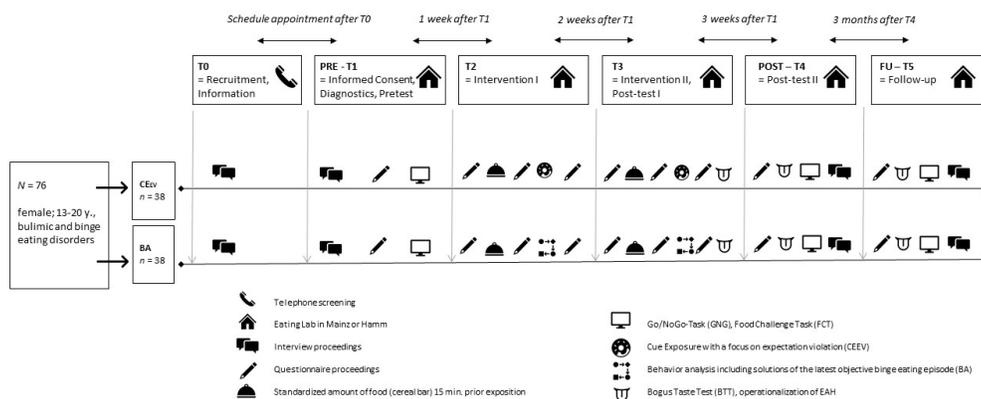


Figure 1. Study flow chart from screening (T0) to 3-month-FU (T5).

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Supplementary material for the manuscript

“Modified Cue Exposure for Adolescents with Binge Eating
Behaviour: Study Protocol of a Randomised Pilot Trial
called EXI_(ea)T”

Hanna Preuss-van Viersen, Inken Kirschbaum-Lesch, Jasmina Eskic, Sophie Lukes,
Jana Pydd, Laura Derks, Florian Hammerle, & Tanja Legenbauer

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Translated version of the CE_{EV} standardised session protocol (Session 1)

1. Brief welcome, clarification of questions, thank the participant for completing the questionnaires
2. Participant's most recent food intake, current level of hunger, and current desire to eat are assessed with VAS (0-100)
3. Standardised food intake (cereal bar); 15 minutes before intervention
4. Implementation of CE_{EV}

4.1. Psychoeducation (aims and procedure of the intervention)

“Exercises with the aim of learning to manage difficulties in food-related situations are often implemented in psychotherapy, because patients perceive them as helpful. In such exercises, a person is confronted with food that typically activates their desire to eat (e.g. chocolate, crisps) and that often leads to problematic behaviour accompanied by the feeling of loss of control (e.g. binge eating). In this exercise, we want to practise this confrontation without the binge eating happening. By doing this exercise, the desire to eat the food can be reduced and you can gain the experience of keeping yourself and your behaviour under control. During the exercise, different aspects of the problematic behaviour can be focused on. We would like to focus on dysfunctional expectations, e.g. “If I see delicious food, I cannot resist eating it.” During the exercise, we can explore whether your expectation comes true or not; e.g. that you cannot resist eating it when you see or taste chocolate. If the expectation does not come true (which is very likely) and you realise that you can withstand the urge to eat, the probability of future binge eating can be reduced.

What happens during the exercise?

During the exercise, you and your therapist look at the food closely and examine it. First, you will smell the food, then you will lick the food and finally you will eat a piece of it without losing control and without binge eating. During the exercise, your therapist will support you and ask you repeatedly about your desire to eat, how difficult it is not to eat the food, and how likely you would be to lose control if your therapist was not present. The exercise can initially be very tiring, but over time your desire to eat and therefore the necessary effort will decrease and your confidence that you will not lose control will increase.”

4.2. Identification of dysfunctional expectations

“To check your expectations in the exercise, it is important to know what your expectations are before starting. Expectations can be very different and sometimes

you are not consciously aware of them. Together with your therapist, you will identify your overeating expectations. For the exercise, it is helpful to raise your awareness with regard to your dysfunctional expectations in the specific food-related situation.”

Examples of possible expectations:

Expectations of the confrontation with your typical binge eating food	“If I see delicious food, I will not be able to resist eating it.” “If I am confronted with sweets, I will lose control.”
Expectations on the process when first signs of desire to eat appear	“If I realise I have a desire to eat, I will eat.” “If I begin to eat, I will never be able to stop.”
Expectations on control over craving/desire to eat	“I cannot resist the desire to eat.” “I am not able to regulate myself.”
Expectations about myself	“After eating I will feel better.” “After eating I will feel less of a failure.”
Further additions	

➔ Please write down two individual expectations on two index cards!

CAVE: Guide the participant to formulate two dysfunctional expectations as an “If CS-then CR” link. If the participant has difficulties formulating individual expectations, offer the two following standardised expectations:

1. “If there’s delicious food in front of me, I will not be able to resist eating it.”
2. “If I eat a small piece of delicious food, I will not be able to stop eating more.”

4.3. The participant rates her level of hunger, her desire to eat, as well as her expectation of overeating on a VAS (0-100)

4.4. Implementation of CE_{EV}

- The exposure ends as soon as the desire to eat has decreased by 50% compared to the highest rating, but after a maximum of 70 minutes.
- Follow the standardised instructions in the table (see below). The questions should be repeated every five minutes. Meanwhile, the participant rates her desire to eat as well as her expectation of overeating with regard to the exposed food on a VAS (0-100).
- If the desire to eat has not decreased by 50% and there is time left after one round (instructions 1 to 4), repeat these instructions (1 to 4).

Instruction Cue Exposure

First, imagery to establish a connection to the place where binge eating usually occurs:

"I would like you to imagine the place where binge eating usually occurs. You are invited to close your eyes or to look at a fixed a point in this room to increase your concentration on this exercise. Now imagine that you are in the place where binge eating usually occurs. Where are you sitting (at home in your kitchen or living room)? What do you see? What do you smell? Where are the foods? What are you doing? What are you experiencing in your body? How do you feel? How strong is your desire to eat (scale 0-100)? Where do you feel the desire to eat (i.e. is your mouth starting to water or is your stomach contracting?"

To increase the transfer to daily life, the following questions should be asked between every instruction and after the cue exposure. In addition, the imagery should be repeated, especially in participants who report a low desire to eat in the session due to the presence of the therapist:

"If you were at home, what would you do? Would your desire to eat be similar? How likely would you be to binge eat at home? What would be different at home?"

1. *Smell the peel and take a piece of it on your hand and also smell the piece.*
 - ➔ *What does the smell do to you, how difficult is it not to eat X? How strong is your desire to eat X at the moment?*
 - ➔ *How does it feel to take X in your hand, how difficult is it not to eat X? How strong is your desire to eat X at the moment?*
2. *Do you think it would be more difficult not to eat X if you were to touch X with your tongue? Or would you lose control? Let`s find out.*
 - ➔ *What`s happening? Why didn`t you lose control?*
 - ➔ *Was it difficult not to eat X after licking it?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*
3. *Do you think it would be more difficult not to eat X if you bit a little piece out of X? Or would you lose control? Let`s find out.*
 - ➔ *What`s happening? Why didn`t you lose control?*
 - ➔ *Was it difficult to stop eating after the bite?*
 - ➔ *Was it difficult to stop eating after chewing it?*
 - ➔ *How was it possible that you stopped eating?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*
4. *How difficult is it not to eat X when you are seeing it at the moment?*
 - ➔ *Why aren`t you losing control?*
 - ➔ *What will you take with you from this exercise?*
 - ➔ *What did you learn from this exercise?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*

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4.5. Participant rates her level of hunger, her desire to eat and her expectation of overeating on a VAS (0-100)

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5. Development of two alternative, helpful expectancies

- Did the two individual expectancies happen? Which expectancies could be more helpful?
- The new expectancies should be written on two index cards for the participant so that she can attach the cards to a visible place or carry the cards with her: *"It has proven helpful to attach the cards to a visible place in your room or to carry the cards in your purse so that you always have them present."*

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6. Discuss home exercises

- If possible, the exercise should be repeated at least twice at home.
- Emphasise the reason for the home exercises: *"Our experience is that it is very helpful to repeat the exercise several times at home so that the transferability to daily life can be increased. Changing a habit takes a lot of practice. Have you ever tried to learn anything new in another situation (i.e. a hobby or language)? How did it go? ..."*
- Validation and anticipation of obstacles and avoidance tendencies, i.e. *"Other adolescents reported concerns that doing the home exercise would lead to binge eating/ strong emotions or would trigger negative emotions. How does it feel for you?"*
- Consider possible times and conditions together with the participant to increase the motivation to do the exercises (i.e. who buys the food or whether the food should be stored by the parents)
- For standardisation, the exposed binge food of the session should also be used as the food for exposure in the home exercise.
- Depending on the course of the preceding exposure, the home exercise can be done with the same or with changed dysfunctional expectations.
- Show the participant the exercise booklet and hand it to her.
- Show the protocol sheet and explain it. The participant should bring the protocol sheet to the next session.

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7. Remind the participant about the second intervention session (T3) and remind her that she should eat sufficiently, but not within the last two hours before the intervention.

8. Participant discharge



STANDARD PROTOCOL ITEMS: RECOMMENDATIONS FOR INTERVENTIONAL TRIALS

SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description	Addressed on page number
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	1
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	3
	2b	All items from the World Health Organization Trial Registration Data Set	1, 3, 9-17, see also DRKS00024009
Protocol version	3	Date and version identifier	3
Funding	4	Sources and types of financial, material, and other support	17
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	1, 17
	5b	Name and contact information for the trial sponsor	NA
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	NA

1		5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	NA
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9	Introduction			
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11	Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	7-8
12				
13		6b	Explanation for choice of comparators	4
14				
15	Objectives	7	Specific objectives or hypotheses	8-9
16				
17	Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	9
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22	Methods: Participants, interventions, and outcomes			
23				
24	Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	9
25				
26	Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	9-10, 11
27				
28	Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	11-12, 10
29				
30		11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	NA
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32		11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	10-11
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34		11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	10
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1	Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	12-13
6	Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	10
10	Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	14
13	Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	10

15 **Methods: Assignment of interventions (for controlled trials)**

17 Allocation:

19	Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	10
25	Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	10
30	Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	10-11
33	Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	10
36		17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	10

40 **Methods: Data collection, management, and analysis**

1	Data collection	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related	10-11, 13
2	methods		processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of	
3			study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known.	
4			Reference to where data collection forms can be found, if not in the protocol	
5				
6		18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be	10
7			collected for participants who discontinue or deviate from intervention protocols	
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9	Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality	10
10			(eg, double data entry; range checks for data values). Reference to where details of data management	
11			procedures can be found, if not in the protocol	
12				
13				
14	Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the	14-15
15			statistical analysis plan can be found, if not in the protocol	
16				
17		20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	15
18				
19		20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any	14-15
20			statistical methods to handle missing data (eg, multiple imputation)	
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23	Methods: Monitoring			
24				
25	Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of	NA
26			whether it is independent from the sponsor and competing interests; and reference to where further details	
27			about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not	
28			needed	
29				
30		21b	Description of any interim analyses and stopping guidelines, including who will have access to these	NA
31			interim results and make the final decision to terminate the trial	
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34	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse	15
35			events and other unintended effects of trial interventions or trial conduct	
36				
37	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent	NA
38			from investigators and the sponsor	
39				
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41	Ethics and dissemination			
42				
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1	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	15
2				
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4	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	15
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8	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	15
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11		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	NA
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13				
14	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	15
15				
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18	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	17
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21	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	9
22				
23				
24	Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	NA
25				
26				
27	Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	15
28				
29		31b	Authorship eligibility guidelines and any intended use of professional writers	15
30				
31		31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	NA
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36 Appendices

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1	Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	Patient and Parent informed consent + Supplement (CE _{EV} standardised session protocol)
9	Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	NA

*It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items. Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons “Attribution-NonCommercial-NoDerivs 3.0 Unported” license.

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BMJ Open

Modified Cue Exposure for Adolescents with Binge Eating Behaviour: Study Protocol of a Randomised Pilot Trial called EXI(ea)T

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Primary Subject Heading:	Mental health
Secondary Subject Heading:	Diagnostics
Keywords:	Child & adolescent psychiatry < PSYCHIATRY, Eating disorders < PSYCHIATRY, Adult psychiatry < PSYCHIATRY

SCHOLARONE™
Manuscripts

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3 **1** **Modified Cue Exposure for Adolescents**
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5 **2** **with Binge Eating Behaviour:**
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7 **3** **Study Protocol of a Randomised Pilot Trial called EXI_(ea)T.**
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13 6 Hanna Preuss-van Viersen^{a*}, Inken Kirschbaum-Lesch^{b*}, Jasmina Eskic^a, Sophie
14 7 Lukes^a, Jana Pydd^b, Laura Derks^b, Florian Hammerle^a, & Tanja Legenbauer^b
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52 29 **Key words:** cue-exposure, expectancy violation, response inhibition, binge eating,
53 30 adolescents, bulimia nervosa, binge eating disorder
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56 31 **Word count:** 5047
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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

32 **Abstract**

33 Introduction: Binge eating (BE) behaviour is highly prevalent in adolescents, and can
34 result in serious metabolic derangements and overweight in the long term. Weakened
35 functioning of the behavioural inhibition system is one potential pathway leading to BE.
36 Food cue exposure focusing on expectancy violation (CE_{EV}) is a short intervention for
37 BE that has proven effective in adults but has never been tested in adolescents. Thus,
38 the current randomised pilot trial evaluates the feasibility of CE_{EV} for adolescents and
39 its efficacy in reducing eating in the absence of hunger (EAH) of binge food items.

40 Methods and analysis: The trial will include $N = 76$ female adolescents aged between
41 13 and 20 years with a diagnosis of bulimia nervosa (BN), binge eating disorder (BED),
42 or their subthreshold forms based on the DSM-5. Participants will be randomly
43 assigned to two sessions of CE_{EV} or behavioural analysis (BA), a classical CBT-based
44 intervention. The primary endpoint is the change in EAH measured according to ad
45 libitum consumption of personally preferred binge food in a bogus taste test at post-
46 test based on the intention-to-treat (ITT) population. Key secondary endpoints are
47 changes in EAH of standardised binge food at post-test, in EAH at 3-month follow-up
48 (FU), and in food craving after induction of food cue reactivity at posttest and FU. To
49 identify further valid outcome parameters, we will assess effects of CE_{EV} compared to
50 BA on global ED psychopathology, BE frequency within the last 28 days, body weight,
51 response inhibition, and emotion regulation abilities. Treatment groups will be
52 compared using analysis of covariance (ANCOVA) with intervention as fixed factor and
53 BMI at baseline as covariate.

54 Ethics and dissemination: This clinical trial has been approved by the Ethics Review
55 Committee of the Medical Association of Rhineland-Palatinate and the Medical Faculty
56 of the Ruhr-University Bochum. The collected data will be disseminated locally and
57 internationally through publications in relevant peer-reviewed journals and will be
58 presented at scientific and clinical conferences. Participants data will only be published
59 in anonymised form.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

63 **Strengths and limitations of this study**

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- EXI_(ea)T is a randomised pilot trial comparing cue exposure with expectancy violation (CE_{EV}) to behavioural analysis (BA) of binge eating (BE) episodes, the gold standard intervention of cognitive behaviour therapy (CBT).
 - CE_{EV} is informed by previous evidence in adults with BE episodes and youth with obesity integrating age-appropriate material for a transdiagnostic adolescent sample.
 - The multimodal assessment approach uses an objective measure as the primary outcome, ad libitum food intake.
 - As a multicentre trial, EXI_(ea)T enables a generalisation of the proof-of-concept, and contributes to quality assurance in the cooperating centres.
 - Due to the short follow-up period of three months, no conclusions about the long-term efficacy of CE_{EV} for eating disorder psychopathology and body weight can be drawn.

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79 **Protocol version 9.0, 25/07/2022**

80 **Trial registration:** German Clinical Trials Register, DRKS00024009, 22/01/2021

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

81 INTRODUCTION

82 *Binge eating in adolescents*

83 Binge eating (BE) behaviour refers to recurrent episodes of impulsive overeating
84 accompanied by the feeling of loss of control over eating. About 18% of 16-year-old
85 adolescents reported BE as a single symptom at least sometimes, 8.5% even weekly
86 during the last year.^{1 2} BE is a core feature of both bulimia nervosa (BN) and binge
87 eating disorder (BED), which show high prevalences of 0.9% to 3% (BN) and 1.3% to
88 5% (BED) in youth with overweight.^{3 4 5} However, the majority of affected youth do not
89 seek treatment as they associate BE with shame and guilt, leading to a long illness
90 duration (8 to 14 years) and to a persistence of adverse outcomes into adulthood.^{5 6}
91 Available first-line treatments for BE-related disorders in youth are mostly based on
92 “enhanced” cognitive behaviour therapy for EDs (CBT-E).⁷ Behavioural analysis (BA)
93 of BE episodes is among the gold standard interventions within CBT-E, and focuses
94 on early symptom changes.⁸ CBT-E has been shown to be effective in achieving BE
95 abstinence in almost 50% of patients with BN, but remission rates are lower in youth
96 than in adults, e.g. 29% remitted.⁹ Initial findings for CBT-E in adolescents with BED
97 suggest that abstinence rates are comparable to those in adults, ranging between 43
98 and 61%.^{10 11} Given the higher number of early responders in CBT-E compared to
99 other therapy approaches, BA can be seen as at least partially responsible for the rapid
100 therapeutic effects.^{12 13}
101 In sum, at least 50% of youth continue to have BE episodes or certain impulsive eating
102 behaviour patterns as residual symptoms at the end of treatment. One reason for this
103 might be that the direct underlying mechanism - food-related inhibitory control deficits
104 - is rarely targeted in conventional treatment programs.

105 106 *Inhibitory control as an underlying mechanism*

107 Recent studies emphasize an association of BE with self-reported impulsivity and
108 behaviourally measured inhibitory control deficits.^{14 15} Inhibitory control is
109 conceptualised as the ability to inhibit impulsive responses in order to select a more
110 value-based functional behaviour, e.g. eating out of deliberate pleasure instead of
111 impulsivity.¹⁶ Response inhibition in general, and towards food stimuli might be
112 impaired in adults with bulimic-type EDs¹⁷, although evidence for adolescents with BE
113 is predominantly only available for non-clinical samples.^{18 19} Moreover, a recent study

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 114 revealed that adolescents with obesity and BED displayed a poorer inhibition
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6 115 performance compared to normal-weight adolescents²⁰, although the study did not
7
8 116 allow for any conclusions on stimulus specificity. Studies examining samples with
9
10 117 overweight have yielded contradictory findings: While one study reported that children
11
12 118 were less effective in food-specific response inhibition²¹, we found that adolescent
13
14 119 psychiatric inpatients showed a rather generally impaired inhibitory control irrespective
15
16 120 of ED pathology.²² Analogous to adults, it can be assumed that there is a specific
17
18 121 subgroup of youth with impulsive eating patterns and inhibitory control deficits,
19
20 122 presumably more generalised based on their current stage of development.
21
22 123 In this framework, the dual-pathway model by Hofmann and colleagues²³ postulates
23
24 124 that BE is controlled via two processes - 1. automatic, unconscious processes and 2.
25
26 125 reflexive, conscious processes. Automatic responses to food stimuli are primarily
27
28 126 associated with the rewarding component of impulsive behaviour. This appetitive
29
30 127 responding may be related to reward sensitivity and food-related inhibition deficits and
31
32 128 is based on a heightened reactivity to palatable food cues or non-food cues that signal
33
34 129 the availability of tempting food, i.e. food cue-reactivity.^{24 25} In turn, top-down processes
35
36 130 primarily involve executive functions such as emotion regulation and general inhibition
37
38 131 abilities and are designed to counteract automatic behaviour.^{26 27} A weakened reflexive
39
40 132 system can be overridden by strong impulsive reactions to appetitive food stimuli,
41
42 133 resulting in food craving and BE. Crucially, the impaired inhibitory control seems to be
43
44 134 met with a hyperresponsive reward system due to neuroadaptive changes in reward
45
46 135 circuits (see maintenance model for BE).²⁸
47
48 136 In line with the dual-process model, recent findings have highlighted the interaction
49
50 137 between emotion regulation and inhibitory control in terms of predicting BE.^{29 30} In an
51
52 138 adult sample with self-reported ED symptoms, eating expectancies mediated the
53
54 139 relationship between emotion regulation difficulties and BE, but only in individuals with
55
56 140 reward-based inhibition deficits.³⁰ Moreover, adolescents with poor self-reported
57
58 141 inhibition experienced more uncontrolled eating, but only in the case of a negative
59
60 142 mood.³¹
61
62 143 In sum, food-related inhibitory control deficits might act as an underlying perpetuating
63
64 144 mechanism of BE, but studies examining interventions to address these deficits are
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66 145 lacking. So far, research has not identified an intervention for impulsive eating

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 146 behaviour that integrates food stimuli and has proven to be superior to other
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6 147 approaches.^{10 32}

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9 149 *Inhibitory learning approach to exposure*

10
11 150 One option to improve food-related inhibitory control is food cue exposure (CE), i.e.
12
13 151 exposure to typical binge food and its stimulus characteristics, such as the taste or
14
15 152 smell of a food, while preventing food consumption. The effect of CE on BE is often
16
17 153 measured by the intake of palatable foods in laboratory paradigms, i.e. eating in the
18
19 154 absence of hunger (EAH) in line with Birch and colleagues.³³

20 155 Researchers have discussed two potential working mechanisms for CE in the area of
21
22 156 BE: habituation and inhibitory learning. Initially, CE was seen as classical extinction
23
24 157 training derived from principles of learning theory. Treatment manuals postulating
25
26 158 habituation as a rationale recommend that patients focus on their desire to eat on a
27
28 159 psychological and physiological level, while food stimuli (conditioned stimuli, CS) are
29
30 160 presented in order to reduce food cue reactivity (conditioned appetitive responses, CR)
31
32 161 via in-session habituation.³⁴ Since the 1980s, CE with habituation has mainly been
33
34 162 researched for the treatment of BN, although over the years, this intervention was
35
36 163 forgotten somewhat due to the complexity of implementing it in clinical practice.³⁵⁻³⁸

37 164 Recently, CE has been experiencing a revival in the treatment of BN and BED, with
38
39 165 inhibitory control being used as rationale.³⁹⁻⁴¹ Research in anxiety disorders suggests
40
41 166 that repeated exposure creates a new inhibitory association such that binge food then
42
43 167 also signals the non-availability of the unconditioned eating response, i.e. a new CS-
44
45 168 noUS pairing.⁴² To enhance inhibitory learning in CE, sessions should be designed so
46
47 169 as to maximize the discrepancy between the expectancy of overeating and what really
48
49 170 happens, namely no overeating.⁴³ Magson and colleagues⁴⁴ even assume that
50
51 171 habituation occurs because of inhibitory learning - if patients are exposed to food in
52
53 172 such a way that their CS-US expectancies are not violated, no habituation processes
54
55 173 will occur and they will be vulnerable to relapses. This assumption is also in line with
56
57 174 observations that habituation within and between sessions, i.e. desire to eat, is not
58
59 175 beneficially related to EAH and weight loss^{39 43 45}, whereas changes in expectancies
60
176 were found to mediate treatment success regarding EAH.⁴³ Accordingly, CE should
177 optimize the violation of idiographic beliefs about eating behaviour when confronted
178 with the relevant binge food (e.g. "If I have milk chocolate next to me when I am sitting

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 179 alone doing my homework, I have to eat the whole bar.”). In CE with expectancy
5 violation (CE_{EV}), these beliefs are checked against what actually happens, i.e. the
6 180 feared BE does not occur, which may strengthen the inhibitory pathway (e.g. “If I have
7 181 milk chocolate [...], I am able to resist eating the whole bar.”). Moreover, there is
8 182 evidence that different impulsive response domains (affective, cognitive and
9 183 behavioural) exist and improvements in one domain in turn favour inhibition control in
10 184 the other two domains.⁴⁶ It can be assumed that there is an improvement in self-
11 185 efficacy through the implementation of positive expectations, such as being able to
12 186 resist binge foods (cognitive self-control) and, with a delay, also an improvement in
13 187 affective and behavioral self-control. Consequently, possible underlying mechanisms
14 188 of change such as emotion regulation abilities and inhibitory control will be altered due
15 189 to their interactions with BE expectancies.²⁹⁻³¹

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192 *Food cue exposure with expectancy violation influencing BE*

193 A recent review⁴⁴ included 16 studies that investigated CE in adults with BE, three of
194 which focused on expectancy violation.^{39 43 45} Regardless of its focus, CE significantly
195 reduced overeating expectancies, desire to eat, and EAH as measured by kcal
196 consumption during a subsequent bogus taste test (BTT).³⁹ In addition, relative to a
197 lifestyle intervention, CE_{EV} was more effective in reducing the number of BE episodes
198 and also in reducing weight from baseline to 3-month follow-up (FU) in women with
199 overweight ($d = 0.67$ and $d = 0.65$).⁴³ Moreover, EAH for exposed food decreased
200 significantly in CE_{EV} ($d = 0.35 - 0.81$)⁴⁵, but this finding did not generalize to non-
201 exposed food.⁴³ The opposite findings emerged for non-personalised exposed food
202 items.^{43 45} It can be suggested that personalised food items might better capture
203 individual learning processes and should thus be included in CE in order to achieve
204 more profound changes in food-related inhibitory control.

205 With regard to mechanisms of change, both generic and idiographic BE expectancies
206 were found to be more effectively disconfirmed in CE_{EV} , with $d = 4.12$ and $d = 9.50$,
207 compared to active control interventions.^{43 45} Moreover, in a recent within-group pilot
208 study, significant improvements in expectancies about ability to tolerate distress were
209 found after five sessions of CE_{EV} in women with BED.⁴⁷ Interestingly, expectancy
210 violations (idiographic CS-US and distress tolerance expectancies) were found prior to
211 changes in BE frequency, emphasizing their assumed potential for subsequent

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

212 habituation processes.^{44 47} To date, only one study has assessed self-reported
213 impulsivity: Participants were randomized to an 8-session group intervention focusing
214 on CE or a control intervention with both conditions including self-monitoring
215 techniques.⁴⁰ No between-group differences emerged. To the best of our knowledge,
216 however, no research has assessed the efficacy of CE for food-related inhibitory
217 control and emotion regulation.

218 With respect to adolescent samples, CE has only been applied in two studies to date.³⁹
219 ⁴⁸ In patients with BN aged 14 to 19 years who had not responded well to CBT, a 12-
220 session CE with habituation was effective in significantly decreasing BE and purging
221 from baseline to post-treatment and at 6-month FU.⁴⁸ Schyns and colleagues³⁹
222 compared CE_{EV} with a lifestyle intervention in a clinical sample of adolescents with
223 obesity. The main focus of the lifestyle intervention was on providing psychoeducation
224 to increase healthier eating and physical activity. Two sessions of CE_{EV} were
225 conducted and EAH was assessed as the primary endpoint, operationalised by the
226 percentage of consumed kcal in a BTT relative to the personal daily energy
227 requirement. CE_{EV} significantly reduced the ad libitum food intake of an exposed food
228 item (chocolate mousse) and of non-exposed food items compared to the control
229 condition ($d = 0.80$ and $d = 0.76$). Contrary to findings in adults, the exposure effects
230 generalised to further highly palatable food, suggesting that adolescents might learn
231 faster.³⁹ It can therefore be assumed that not all relevant food cues need to be
232 integrated into CE_{EV} sessions. However, adherence to homework exercises was poor,
233 suggesting the need for stronger guidance of CE_{EV} at home, especially in this young
234 age group.

235 To sum up, evidence in adults and in adolescents with obesity indicates medium to
236 large effect sizes regarding the improvement of EAH via ad libitum food intake, eating
237 psychopathology, and weight reduction after only two sessions of CE_{EV}. However,
238 more RCTs are needed to support this inhibitory learning approach to exposure in
239 adolescents with BE.

240

241 **STUDY AIMS AND HYPOTHESES**

242 The current pilot study, called EXI_(ea)T, targets the feasibility and efficacy of CE_{EV} for
243 adolescents with recurrent BE episodes relative to BA in a multicentre randomised trial.
244 EXI_(ea)T is an acronym for *EXIT* strategies as a way out of binge eating. The diagnosis

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

of BE episodes in adolescents can be challenging for a number of reasons. First, adolescents who still live at home and are financially dependent of their parents do not have unrestricted access to food - therefore the consumption during a BE and the frequency can be externally limited. Second, there is evidence that loss of control over eating may be more important, especially in view of the large amounts of food that can be eaten due to pubertal developmental spurts. Accordingly, it is important to consider also subthreshold BN and BED in adolescents. Marcus and Kalarchian⁴⁹ next to Tanofsky-Kraff and colleagues⁵⁰ have proposed modified criteria for BED in childhood and adolescence. For the diagnosis "recurrent episodes of BE persisting over a period of 3 months" are required which has also found its way into the new ICD-11 criteria. Based on our clinical ED expertise, we applied a low-threshold cut-off of only three objective BE episodes within the last three months although a typical clinical picture is present. Recurrent BE episodes are therefore operationalised by a diagnosis of BN, BED, or Other Specified Feeding or Eating Disorder (OSFED-BN/BED). Taken together, the aims of EXI_(ea)T are to investigate (1) the application of CE_{EV} compared to BA in a transdiagnostic adolescent sample with BE, (2) whether CE_{EV} effectively reduces EAH and food craving at post-treatment and at 3-month FU, and (3) the effect of CE_{EV} on global ED pathology, number of binge episodes and weight, and (4) on underlying mechanisms of change, i.e. expectancy violations. We hypothesize that CE_{EV} will be superior to BA in reducing ad libitum food intake of personally preferred exposed and non-exposed binge foods beyond physiological needs at post-test. With regard to secondary endpoints, we expect CE_{EV} to lead to a stronger decrease in ad libitum intake of standardised binge food, food craving, ED psychopathology, and BE frequency and to a stronger weight reduction at FU compared to BA. Moreover, we hypothesize that adolescents in the CE_{EV} condition will additionally benefit with respect to larger violations of BE expectancies. On an exploratory level, we will analyse potential moderating effects of food-related response inhibition and emotion regulation abilities.

273

274 **METHODS AND ANALYSIS**

275 **Patient and Public Involvement**

276 The modified CE was developed from clinical work with adolescents with EDs. To
277 ensure appropriateness of CE_{EV} for the relevant clinical group and age range, a

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

278 preliminary study on treatment expectations was conducted with a student sample
279 aged 18-25 years who experienced stress-induced chocolate cravings. Help-seeking
280 rates in adolescents that meet BN or BED criteria are very low with 11.6% and 22.3%⁵¹
281 what underlines the significant delay from onset of symptoms to accessing eating
282 disorder-specific treatment.⁵² Consequently, for economic and ethical reasons, we
283 included young students in the preliminary study. The results on treatment
284 expectations were used to optimise the CE before inclusion of the first patient.

285

286 **Study design**

287 This study is a randomized (with a 4:4 allocation ratio), controlled, double-blind
288 multicentre trial comparing CE_{EV} to BA. Recruitment, data collection, interventions and
289 data analysis are conducted in two departments of child and adolescent psychiatry and
290 psychotherapy at the University Hospital Bochum and the University Medical Center
291 Mainz.

292

293 **Participants and recruitment**

294 The following inclusion criteria are applied 1) female adolescents aged 13;00 to 20;11
295 years; 2) presence of recurrent BE episodes (at least three objective episodes within
296 the last three months with loss of control and clinically significant distress/functional
297 impairment) assessed via an expert interview (Eating Disorder Examination, EDE^{53 54});
298 3) diagnosis of BN, BED or OSFED-BN/BED (BN or BED of low frequency and/or
299 limited duration) based on DSM-5; 4) sufficient knowledge of the German language;
300 and 5) written informed consent of the participant and the caregivers. Adolescents are
301 excluded if they show 1) severe psychopathological comorbidities (such as severe
302 depressive episodes, borderline personality disorder, substance use disorder,
303 dissociative disorders, diagnosis of non-suicidal self-injury based on DSM-5), although
304 mild to moderate comorbidities do not lead to exclusion as long as ED symptoms are
305 the core symptoms; 2) anorexia nervosa; 3) immediate need for inpatient treatment
306 due to acute suicidality or BE/purging at a high frequency; and 4) ongoing outpatient
307 treatment with a focus on ED-specific interventions (e.g. CE, mirror exposure). The
308 participants are recruited via press releases, flyers, and social media, as well as in
309 schools, and youth centres in Hamm and Mainz and the surrounding areas. In addition,

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

310 cooperations with counselling centres, child and adolescent psychiatrists and
311 psychotherapists, and pediatricians are used for recruitment.

312

313 **Study flow and procedure**

314 The study flow is illustrated in Fig. 1. First, subjects and their caregivers are informed
315 about the aims and procedure of the study in a telephone interview (T_0). In addition,
316 the inclusion and exclusion criteria are checked.

317

318 *Please insert Figure 1 here.*

319

320 At the beginning of each session, participants' most recent food intake is assessed
321 and their current levels of hunger and desire to eat are measured on a 100mm visual
322 analogue scale (VAS). At the baseline assessment (T_1), participants undertake two
323 computer-based tasks (Food Challenge Task, FCT⁵⁵; Go/NoGo Task, GNG^{56 57}),
324 before their weight, height and body fat percentage are measured by bioelectrical
325 impedance analysis (BIA). Moreover, general psychopathology is assessed and the
326 EDE-II and an interview on binge food (in which participants are asked to state four
327 personally preferred binge foods) are conducted. After a short break, relevant parts of
328 the Diagnostic Interview for Mental Disorders in Children and Adolescents (Kinder-
329 DIPS-OA)⁵⁸ are conducted. The remaining self-rating questionnaires are completed
330 online via REDCap.⁵⁹ The randomisation takes place after T_1 using a blockwise
331 procedure (block sizes of four) by Sealed Envelope that run automatically in the
332 REDCap data management. To ensure that assessors (experienced and trained
333 psychologists) are blinded, the study leaders randomize the participants. Two sessions
334 of CE_{EV} or BA follow at T_2 and T_3 . Participants are requested to eat sufficiently prior to
335 the appointments but not within the last two hours before the intervention. To avoid
336 hunger during the interventions, participants are asked to eat a cereal bar 15 minutes
337 before the intervention. After CE_{EV} and BA, current levels of hunger, desire to eat, and
338 the two relevant overeating expectancies in the CE_{EV} group are assessed again. At the
339 end of the intervention sessions, participants are strongly encouraged to repeat the
340 exercise at home to increase the transferability to daily life. We look for specific
341 favourable times of day for the implementation and anticipate possible difficulties or
342 obstacles. The participants also receive an exercise booklet with general information

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

343 about the intervention as well as detailed instruction and protocol sheets. At the
344 beginning of T₃, these home exercises, obstacles to implementation and potential
345 solutions are discussed and participants are again encouraged to continue with the
346 exercises at home. At the end of T₃, a BTT with all four preferred binge foods is
347 conducted. The BTT is a valid and sensitive instrument to investigate whether
348 experimental manipulations effect food intake with respect to EAH⁶⁰ and has been
349 applied in obese adolescents.³⁹ To ensure that participants were not aware of the aims
350 of the experimental hypotheses, they are asked to evaluate the taste of the foods on a
351 rating sheet during a set time period of 15 min.⁶⁰ They are invited to eat as much as
352 they need to evaluate the taste. Before and after the rating, the weight of the food is
353 measured out of sight of the participants and the consumed calories are calculated.
354 The dependent variable is the percentage of consumed calories in relation to the
355 individual's daily energy demand with respect to age and gender (recommendation of
356 the World Health Communication).
357 At the post-assessment (T₄), the frequency of home exercises is discussed again. Next,
358 a BTT is performed with standardised non-exposed food items (milkshakes), and the
359 computer-based tasks are repeated. Binge-purge behaviours are assessed. The
360 questionnaires can be completed at home. The post-assessment is repeated at T₅ (FU)
361 three months after T₄. At T₅, the BTT is conducted with three preferred and one
362 standardised binge foods. Any outstanding questionnaires are completed on site to
363 avoid missing data. At the end of T₅, participants receive an allowance of 50€.

Interventions

366 Both conditions include two face-to-face sessions with a maximum duration of 70
367 minutes each. Following a standardised session protocol (see Supplement), the
368 interventions are delivered by experienced CBT therapists at each site. In the CE_{EV}
369 group, participants are exposed to two out of four personally preferred binge food items.
370 Two individual overeating expectancies are used during exposure, and if a subject has
371 difficulties in formulating expectancies, standardised overeating expectancies are
372 applied (i.e. "If I see delicious food, I won't be able to resist eating it."). Directly before
373 CE_{EV} and every five minutes, subjects are asked to rate their current levels of hunger,
374 desire to eat the exposed food, and the two relevant overeating expectancies on a
375 100mm VAS. The exposure ends as soon as the desire to eat has decreased by 50%

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

376 compared to the highest rating, but at the latest after 70 minutes. After the exposure,
377 two alternative, helpful expectancies are developed together with the therapist and are
378 written on two index cards so that the participant can carry them with her. Control group
379 participants undergo a BA of the last BE episode based on the SORKC model.⁶¹ First,
380 situational and preceding factors as well as the cognitive, emotional, physiological and
381 behavioural reactions of the participant are identified. In addition, consequences of the
382 behaviour are detected. The BA ends with a solution analysis by identifying effective
383 skills to prevent BE, but also after 70 minutes at the latest.

384

385 **Diagnostic and outcome assessments**

386

387 ***Patient characteristics and diagnostics***

388 Besides sociodemographic information such as age and school type, general
389 information such as ongoing therapy, and previous treatments is gathered. In addition,
390 information to compute the socioeconomic status (SES; Winkler-Index⁶²) is obtained.
391 To identify possible comorbidities, the Freiburger Screening for Mental Disorders
392 (FSP)⁶³ is used as screening instrument. The sections on depressive disorders, anxiety
393 disorders, ADHD, conduct disorders, tic disorders, enuresis, encopresis and non-
394 suicidal self-injury disorder are administered routinely in the Kinder-DIPS-OA; the other
395 sections are explored in the case of relevant answers in the previously administered
396 FSP. Eating disorder psychopathology is assessed with the well-established interview
397 EDE which allows an accurate clinical judgment of global ED psychopathology over
398 the last 28 days and is considered the gold standard for ED-specific diagnostics.^{53 54}
399 Other diagnostics are general psychopathology⁵⁸, last food intake, level of hunger and
400 desire to eat. Instruments and their psychometric characteristics are illustrated in Table
401 1.

402

403 **Table 1.** Assessment plan from screening (T₀) to 3-month follow-up (T₅).

Variable	Instrument	Description	Score indication	Assessment moments				
				T ₁	T ₂	T ₃	T ₄	T ₅
Diagnostics								
Eligibility screen		Inclusion and exclusion criteria		X				
Clinical baseline data		e.g. age, school type, treatments		X				
General psychopathology - self-report	Strengths and Difficulties Questionnaire (SDQ) ^{64 65}	25 items range from 0-40	Higher scores indicate more externalising and internalising problems	X				
Psychological impairment	Freiburger Screening für psychische Störungen (FSP) ⁶³	Screening questions for 14 mental disorders with 29 items		X				
General psychopathology - clinical judgment	Diagnostic Interview for Mental Disorders in Children and Adolescents (Kinder-DIPS-OA) ⁵⁸	Screening for mental disorders according to the DSM-IV-TR ⁶⁶ and ICD-10 ⁶⁷		X				
Eating disorder psychopathology - clinical judgment	Eating Disorder Examination (EDE) ^{53 54}	Semi-structured interview with 22 and four subscales "Restraint", "Eating concerns", "Shape concerns", and "Weight concerns"	Higher scores indicate more eating disorder psychopathology	X				
Primary outcome								
Eating in the absence of hunger (EAH)	Bogus Taste task (BTT, preferred food items) ⁶⁰	Exposition to their personally preferred food items	Higher consumed calories indicate more EAH			X		X
Secondary outcomes								
Eating in the absence of hunger (EAH)	Bogus Taste task (BTT, standardised food items) ⁶⁰	Exposition to milkshakes	Higher consumed calories indicate more EAH				X	X
Momentary food craving	Food Challenge Task (FCT) ⁵⁵	Craving is measured with the Food Craving Questionnaire-	Higher scores indicate higher intensity of craving	X			X	X

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

		State (FCQ-S) ⁶⁸ , consists of 15 items range from 15-75				
Binge eating	Eating Disorder Examination (EDE) ^{53 54}			X	X	X
Eating disorder psychopathology - self-report	Eating Disorder Examination-Questionnaire (EDE-Q) ^{69 70}	Self-report questionnaire with 22 items	Higher scores indicate more eating disorder psychopathology	X	X	X
Weight, height, body fat	Bioelectrical impedance analysis (BIA), InBody770*			X	X	X
Food craving	Food Craving Questionnaire-Trait (FCQ-T-r) ⁷¹	15 items range from 15-90	Higher scores indicate higher frequency and intensity of food craving	X	X	X
Moderator variables						
Response inhibition	Go/NoGo Task (GNG Task) ^{56 57}	Affective shifting task with high-caloric vs. neutral food stimuli; 16 blocks with a total of 320 trials	Higher number of commission errors indicate lower inhibition skills	X	X	X
Emotion regulation	Difficulties in Emotion Regulation Scale (DERS) ^{72 73}	36 items range from 36-180	Higher scores indicate more difficulties in emotion regulation	X	X	X
Treatment expectation and evaluation						
Treatment expectation	Expectation of Improvement and Suitability of Treatment Form (EIST) ⁷⁴	Two items, rated on a 10-point Likert scale	Higher scores indicate positive treatment expectation	X	X	X
Treatment evaluation	Patient Questionnaire on Therapy Expectation and Evaluation (PATHEV) ⁷⁵	11 items, rated on a 5-point Likert scale	Higher score indicate better treatment evaluation	X	X	X

Notes. T₀ = Telephone interview; T₁ = Baseline assessment; T₂ = Intervention session 1; T₃ = Intervention session 2; T₄ = Post-assessment; T₅ = Follow-up; * Body fat is only measured at the Mainz site.

406 **Primary Outcome**

407 EAH is assessed with BTT, a valid and sensitive instrument to investigate whether
408 experimental manipulations affect food intake.⁶⁰ Participants are exposed to their
409 personally preferred binge foods and are asked to evaluate the taste of the food on a
410 rating sheet. They are invited to eat as much as they need to evaluate the taste. Before
411 and after the rating, the weight of the food is measured and the consumed calories are
412 calculated. The dependent variable is the percentage of consumed calories in relation
413 to the individual's daily energy requirements with respect to age and gender in line with
414 the recommendations of the United Nations University and the World Health
415 Organization.⁷⁶

417 **Secondary Outcomes**

418 EAH is measured with standardized food items in the BTT. Momentary food craving is
419 assessed with the FCT in which a five-minute video with tasty foods is presented to
420 induce craving.⁵⁵ After participants have watched the video, the experience of craving
421 is measured with the Food Craving Questionnaire-State (FCQ-S).⁶⁸ The FCT has
422 proven to be valid for the standardised induction of food cue reactivity to measure
423 momentary food craving.⁵⁵ Other secondary outcome measures are binge eating,
424 eating disorder psychopathology^{69 70}, weight, height, body fat and trait food craving
425 (FCQ-T-r).⁷¹

427 **Moderators**

428 To identify possible moderating effects, emotion regulation is measured with the
429 Difficulties in Emotion Regulation Scale (DERS)^{72 73}, and response inhibition is
430 assessed with a modified personalised GNG affective shifting task (high-calorie food
431 category vs. neutral category).^{56 57} Neutral stimuli (flower, towel) and high-calorie foods
432 (chocolate, pizza) are presented as Go or NoGo stimuli (depending on the block). To
433 determine participants' personal taste preferences, prior to the GNG Task, they are
434 asked to rate 30 high-calorie food stimuli on a 7-point Likert scale (0 = not at all
435 palatable to 6 = extremely palatable). The ten personally most palatable food stimuli
436 are then used in the task. Participants are instructed to press a button when watching
437 a relevant stimulus ("Go") and to not press the button when watching an irrelevant
438 stimulus ("NoGo"). The task consists of 16 blocks with 50% of the stimuli presented as
439 Go stimuli and 50% as NoGo stimuli in each block. Participants receive instructions at

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

the beginning of each block. Each stimulus is presented for 500ms with an inter-trial interval of 1000ms. Dependent variables are participants' reaction times and number of commission errors (false reactions to a NoGo instruction) and omission errors (missing reactions to a Go instruction). The GNG task is a widely used task to measure response inhibition.²²

Additional assessments

Adherence control

Attrition rate and study dropouts are assessed in both treatment groups. Manual adherence across the different therapists is achieved through standardised treatment protocols, online trainings and fortnightly supervisions by a licensed expert in ED treatment (TL) across both participating centres.

Treatment Expectation and Evaluation

Treatment expectation and evaluation are assessed with the Expectation of Improvement and Suitability of Treatment Form (EIST)⁷⁴ and the Patient Questionnaire on Therapy Expectation and Evaluation (PATHEV)⁷⁵.

Sample size calculation

The sample size calculation is based on the publication of Schyns and colleagues³⁹, which reports an effect size of $d = 0.8$ between groups for the percentage of consumed kcal during the taste test relative to the daily energy requirements (experimental group: mean 57% ($N = 21$; $SD = 68\%$), control group: mean 146% ($N = 19$; $SD = 141\%$)). When calculating the pooled standard deviation ($SD_{pooled} = 118.5\%$) and assuming an effect size of 0.8, this results in an absolute difference of 75% in the mean between groups, which can be considered as relevant. When assuming a two-sided significance level, a power of 90%, an effect size of $d = 0.8$ and a sample size of 68 patients (=2x34 patients) will be needed to detect a significant treatment difference at post-assessment when using a t-test. As the duration of treatment is very short (two weeks only), we assume that patient loss due to non-compliance will be minimal. To account for 10% dropouts³⁹, 76 patients should be randomised. The calculation was performed using SAS Version 9.4.

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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474 **Data analysis plan**

475 Regarding the primary outcome EAH, treatment groups will be compared using an
476 analysis of covariance (ANCOVA) with intervention as fixed factor and BMI at baseline
477 as covariate. The primary analysis is performed on the ITT population consisting of all
478 patients randomised next to per-protocol (PP) analyses. The secondary parameters
479 are mostly continuous parameters, and will be analysed using AN(C)OVAs and t-tests.
480 Sample characteristics will be provided. A p-value of < .05 is considered as statistically
481 significant (two-sided). Missing values will not be replaced, however an analysis of
482 potential missing data patterns will be presented. There will be several sensitivity
483 analyses, e.g. by considering additional covariates.

484

485 **Data availability**

486 The research data generated during this study will be available on reasonable request
487 by the corresponding authors. Anonymised data use by other researchers not involved
488 in the study may be done with prior agreement.

489

490 **ETHICS AND DISSEMINATION**

491 **Ethics and safety aspects**

492 The trial will be conducted according to the principles of ICH-GCP and appropriate
493 legal regulations, and will adhere to the Declaration of Helsinki in its latest version.
494 Participating individuals are provided with treatment as usual (TAU which consists of
495 BA) for EDs according to good clinical practice.⁷⁷ The study protocol including
496 amendments has been and will be approved by the responsible ethics committees.
497 Important protocol modifications will be reported to the German Clinical Trials Register
498 and to the journal. Participants and caregivers must provide written informed consent
499 before beginning the study. CE is generally well tolerated^{39 43}, and risks for participants
500 are not known or expected. Trained clinical staff will be available to monitor safety
501 concerns and support patients during/after treatment.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 **503 Dissemination plan**

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6 504 The collected data will be disseminated locally and internationally through publications
7 505 in relevant peer-reviewed journals and will be presented at scientific and clinical
8 506 conferences. Participants data will only be published in anonymised form.
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13 **508 DISCUSSION**

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15 509 Research on effective treatment elements for BE in adolescents is still limited, leaving
16 510 a gap in knowledge on interventions that might enhance outcomes for this age group.
17 511 One promising way to achieve this might be to target food-related inhibitory control as
18 512 an underlying perpetuating mechanism of BE. Recent results suggest a successful
19 513 adaptation of CE_{EV} for pathological eating behavior. However, little is known about the
20 514 feasibility and efficacy of CE_{EV} for adolescents with recurrent BE episodes. Thus, the
21 515 findings of EXI_(ea)T might clarify whether CE_{EV} is accepted by a transdiagnostic
22 516 adolescent sample and whether it is able to reduce the ad libitum consumption of highly
23 517 palatable foods when satiated as well as ED pathology. Furthermore, we will elucidate
24 518 the role of CS-US expectancy violations, response inhibition, and emotion regulation
25 519 in CE_{EV}. The strengths of EXI_(ea)T lie in the inclusion of a credible, active control
26 520 condition, considered as the gold standard intervention of CBT-E to treat BE, and the
27 521 use of an objective measure to assess changes, i.e. ad libitum food intake, as the
28 522 primary efficacy endpoint. Moreover, the CE_{EV} treatment protocol includes the most
29 523 relevant CE strategies to maximize treatment success⁴⁴, i.e. in-vivo exposure,
30 524 personally preferred food cues and non-food cues (due to imagery of trigger situations
31 525 at the beginning of session), occasionally eating allowed and personal CS-US
32 526 expectancies identified. Additionally, to overcome poor homework adherence, we offer
33 527 a detailed exercise booklet, discuss implementation problems and debrief all exercises
34 528 at the beginning of session 2. On the level of limitations, it should be noted that EXI_(ea)T
35 529 cannot evaluate the efficacy of CE_{EV} as an add-on intervention to CBT-E as a whole.
36 530 BA is a very strong control intervention, which could make it difficult to identify a
37 531 significant superiority of CE_{EV}. Moreover, we did not ask explicitly for “new”
38 532 expectations that might arise during the CE_{EV}. Similarly, it should be pointed out that
39 533 there is no data monitoring committee to review accumulating data, which may affect
40 534 the independence of the analyses. In addition, our decision to use the DSM-5 criteria
41 535 and not the age-adapted criteria for BED^{49 78} or modified ICD-11 criteria for bulimic

Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 536 disorders⁷⁹, which emphasize the subjective loss of control (LOC), needs to be
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6 537 explored with respect to recruitment procedures. Indeed, we have not found prior
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8 538 evidence that CE_{EV} is also a valuable intervention with respect to LOC eating.
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10 539 However, if CE_{EV} is effective and feasible for adolescents with BE, we might conduct
11
12 540 a confirmatory randomised trial in order to test CE_{EV} as a useful adjunct to first-line
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14 541 treatment.

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16 543 **Trial status**

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18 544 Recruitment for this trial started in April 2021 and is ongoing.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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4 **548 Contributions**

5
6 549 All authors contributed to the design and conception of this study. HP, IK, JE and TL
7
8 550 elaborated the study protocol and gained ethical approval. HP and IK drafted the
9
10 551 manuscript and JE, SL, JP, LD, FH and TL revised the manuscript critically. All authors
11
12 552 have read and approved the final version of the article submitted.

13 553

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15
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17
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19
20 557 Reiss foundation. This funding had no role in the design of the study and in writing the
21
22 558 manuscript.

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24
25 **560 Competing interests**

26
27 561 TL receives royalties for textbooks in the field of eating disorders from Hogrefe,
28
29 562 Kohlhammer, Springer and DeGruyter as well as funding from the German Ministry of
30
31 563 Education and Research (BMBF) for studies in the field of eating disorders and obesity.
32
33 564 HP receives royalties for a therapy manual for BE from Hogrefe. The other authors
34
35 565 declare that they have no competing interests.

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37 **567 Ethics approval**

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39 568 Ethical approval has been granted by the Ethics Review Committee of the Medical
40
41 569 Association of Rhineland-Palatinate (No. 2020-14980) and of the Medical Faculty of
42
43 570 the Ruhr-University Bochum (No. 20-7051 BR).

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45 **572 Provenance and peer review**

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47 573 Not commissioned; externally peer reviewed.

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING
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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING
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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING BEHAVIOUR

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Running Head: MODIFIED CUE EXPOSURE FOR ADOLESCENTS WITH BINGE EATING
BEHAVIOUR

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4 821 difficulties in emotion regulation scale. *J Psychopathol Behav* 2004;26(1):41-54.
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30 843 **FIGURE LEGEND**

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32 844 **Figure 1.** Study flow chart from screening (T₀) to 3-month-FU (T₅).
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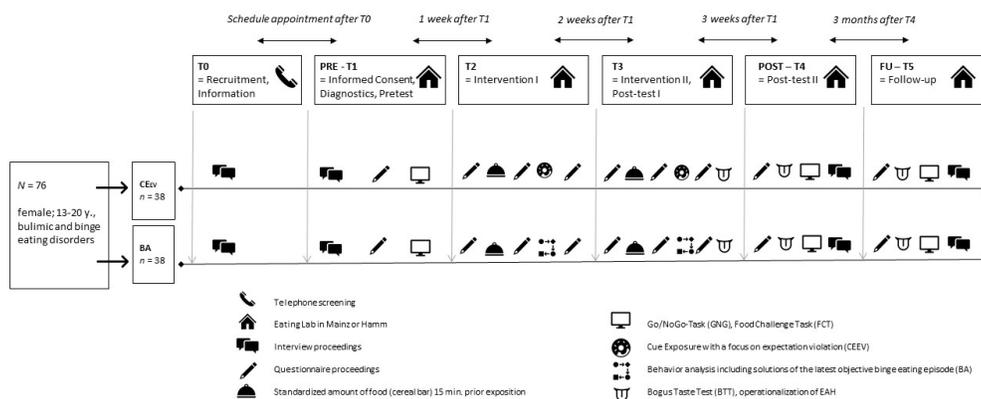


Figure 1. Study flow chart from screening (T0) to 3-month-FU (T5).

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Supplementary material for the manuscript

“Modified Cue Exposure for Adolescents with Binge Eating
Behaviour: Study Protocol of a Randomised Pilot Trial
called EXI_(ea)T”

Hanna Preuss-van Viersen, Inken Kirschbaum-Lesch, Jasmina Eskic, Sophie Lukes,
Jana Pydd, Laura Derks, Florian Hammerle, & Tanja Legenbauer

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Translated version of the CE_{EV} standardised session protocol (Session 1)

1. Brief welcome, clarification of questions, thank the participant for completing the questionnaires
2. Participant's most recent food intake, current level of hunger, and current desire to eat are assessed with VAS (0-100)
3. Standardised food intake (cereal bar); 15 minutes before intervention
4. Implementation of CE_{EV}

4.1. Psychoeducation (aims and procedure of the intervention)

“Exercises with the aim of learning to manage difficulties in food-related situations are often implemented in psychotherapy, because patients perceive them as helpful. In such exercises, a person is confronted with food that typically activates their desire to eat (e.g. chocolate, crisps) and that often leads to problematic behaviour accompanied by the feeling of loss of control (e.g. binge eating). In this exercise, we want to practise this confrontation without the binge eating happening. By doing this exercise, the desire to eat the food can be reduced and you can gain the experience of keeping yourself and your behaviour under control. During the exercise, different aspects of the problematic behaviour can be focused on. We would like to focus on dysfunctional expectations, e.g. “If I see delicious food, I cannot resist eating it.” During the exercise, we can explore whether your expectation comes true or not; e.g. that you cannot resist eating it when you see or taste chocolate. If the expectation does not come true (which is very likely) and you realise that you can withstand the urge to eat, the probability of future binge eating can be reduced.

What happens during the exercise?

During the exercise, you and your therapist look at the food closely and examine it. First, you will smell the food, then you will lick the food and finally you will eat a piece of it without losing control and without binge eating. During the exercise, your therapist will support you and ask you repeatedly about your desire to eat, how difficult it is not to eat the food, and how likely you would be to lose control if your therapist was not present. The exercise can initially be very tiring, but over time your desire to eat and therefore the necessary effort will decrease and your confidence that you will not lose control will increase.”

4.2. Identification of dysfunctional expectations

“To check your expectations in the exercise, it is important to know what your expectations are before starting. Expectations can be very different and sometimes

you are not consciously aware of them. Together with your therapist, you will identify your overeating expectations. For the exercise, it is helpful to raise your awareness with regard to your dysfunctional expectations in the specific food-related situation.”

Examples of possible expectations:

Expectations of the confrontation with your typical binge eating food	“If I see delicious food, I will not be able to resist eating it.” “If I am confronted with sweets, I will lose control.”
Expectations on the process when first signs of desire to eat appear	“If I realise I have a desire to eat, I will eat.” “If I begin to eat, I will never be able to stop.”
Expectations on control over craving/desire to eat	“I cannot resist the desire to eat.” “I am not able to regulate myself.”
Expectations about myself	“After eating I will feel better.” “After eating I will feel less of a failure.”
Further additions	

➔ Please write down two individual expectations on two index cards!

CAVE: Guide the participant to formulate two dysfunctional expectations as an “If CS-then CR” link. If the participant has difficulties formulating individual expectations, offer the two following standardised expectations:

1. “If there’s delicious food in front of me, I will not be able to resist eating it.”
2. “If I eat a small piece of delicious food, I will not be able to stop eating more.”

4.3. The participant rates her level of hunger, her desire to eat, as well as her expectation of overeating on a VAS (0-100)

4.4. Implementation of CE_{EV}

- The exposure ends as soon as the desire to eat has decreased by 50% compared to the highest rating, but after a maximum of 70 minutes.
- Follow the standardised instructions in the table (see below). The questions should be repeated every five minutes. Meanwhile, the participant rates her desire to eat as well as her expectation of overeating with regard to the exposed food on a VAS (0-100).
- If the desire to eat has not decreased by 50% and there is time left after one round (instructions 1 to 4), repeat these instructions (1 to 4).

Instruction Cue Exposure

First, imagery to establish a connection to the place where binge eating usually occurs:

"I would like you to imagine the place where binge eating usually occurs. You are invited to close your eyes or to look at a fixed a point in this room to increase your concentration on this exercise. Now imagine that you are in the place where binge eating usually occurs. Where are you sitting (at home in your kitchen or living room)? What do you see? What do you smell? Where are the foods? What are you doing? What are you experiencing in your body? How do you feel? How strong is your desire to eat (scale 0-100)? Where do you feel the desire to eat (i.e. is your mouth starting to water or is your stomach contracting?"

To increase the transfer to daily life, the following questions should be asked between every instruction and after the cue exposure. In addition, the imagery should be repeated, especially in participants who report a low desire to eat in the session due to the presence of the therapist:

"If you were at home, what would you do? Would your desire to eat be similar? How likely would you be to binge eat at home? What would be different at home?"

1. *Smell the peel and take a piece of it on your hand and also smell the piece.*
 - ➔ *What does the smell do to you, how difficult is it not to eat X? How strong is your desire to eat X at the moment?*
 - ➔ *How does it feel to take X in your hand, how difficult is it not to eat X? How strong is your desire to eat X at the moment?*
2. *Do you think it would be more difficult not to eat X if you were to touch X with your tongue? Or would you lose control? Let`s find out.*
 - ➔ *What`s happening? Why didn`t you lose control?*
 - ➔ *Was it difficult not to eat X after licking it?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*
3. *Do you think it would be more difficult not to eat X if you bit a little piece out of X? Or would you lose control? Let`s find out.*
 - ➔ *What`s happening? Why didn`t you lose control?*
 - ➔ *Was it difficult to stop eating after the bite?*
 - ➔ *Was it difficult to stop eating after chewing it?*
 - ➔ *How was it possible that you stopped eating?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*
4. *How difficult is it not to eat X when you are seeing it at the moment?*
 - ➔ *Why aren`t you losing control?*
 - ➔ *What will you take with you from this exercise?*
 - ➔ *What did you learn from this exercise?*
 - ➔ *How difficult is it not to eat X at the moment? How strong is your desire to eat X at the moment?*

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4.5. Participant rates her level of hunger, her desire to eat and her expectation of overeating on a VAS (0-100)

5. Development of two alternative, helpful expectancies

- Did the two individual expectancies happen? Which expectancies could be more helpful?
- The new expectancies should be written on two index cards for the participant so that she can attach the cards to a visible place or carry the cards with her: *“It has proven helpful to attach the cards to a visible place in your room or to carry the cards in your purse so that you always have them present.”*

6. Discuss home exercises

- If possible, the exercise should be repeated at least twice at home.
- Emphasise the reason for the home exercises: *“Our experience is that it is very helpful to repeat the exercise several times at home so that the transferability to daily life can be increased. Changing a habit takes a lot of practice. Have you ever tried to learn anything new in another situation (i.e. a hobby or language)? How did it go? ...”*
- Validation and anticipation of obstacles and avoidance tendencies, i.e. *“Other adolescents reported concerns that doing the home exercise would lead to binge eating/ strong emotions or would trigger negative emotions. How does it feel for you?”*
- Consider possible times and conditions together with the participant to increase the motivation to do the exercises (i.e. who buys the food or whether the food should be stored by the parents)
- For standardisation, the exposed binge food of the session should also be used as the food for exposure in the home exercise.
- Depending on the course of the preceding exposure, the home exercise can be done with the same or with changed dysfunctional expectations.
- Show the participant the exercise booklet and hand it to her.
- Show the protocol sheet and explain it. The participant should bring the protocol sheet to the next session.

7. Remind the participant about the second intervention session (T3) and remind her that she should eat sufficiently, but not within the last two hours before the intervention.

8. Participant discharge



SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description	Addressed on page number
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	1
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	3
	2b	All items from the World Health Organization Trial Registration Data Set	1, 3, 9-17, see also DRKS00024009
Protocol version	3	Date and version identifier	3
Funding	4	Sources and types of financial, material, and other support	17
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	1, 17
	5b	Name and contact information for the trial sponsor	NA
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	NA

1		5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	NA
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9	Introduction			
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11	Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	7-8
12				
13		6b	Explanation for choice of comparators	4
14				
15	Objectives	7	Specific objectives or hypotheses	8-9
16				
17	Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	9
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22	Methods: Participants, interventions, and outcomes			
23				
24	Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	9
25				
26	Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	9-10, 11
27				
28	Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	11-12, 10
29				
30		11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	NA
31				
32		11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	10-11
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34		11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	10
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1	Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	12-13
6	Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	10
9	Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	14
13	Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	10

Methods: Assignment of interventions (for controlled trials)

Allocation:

19	Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	10
25	Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	10
30	Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	10-11
33	Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	10
36		17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	10

Methods: Data collection, management, and analysis

1	Data collection	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related	10-11, 13
2	methods		processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of	
3			study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known.	
4			Reference to where data collection forms can be found, if not in the protocol	
5				
6		18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be	10
7			collected for participants who discontinue or deviate from intervention protocols	
8				
9	Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality	10
10			(eg, double data entry; range checks for data values). Reference to where details of data management	
11			procedures can be found, if not in the protocol	
12				
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14	Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the	14-15
15			statistical analysis plan can be found, if not in the protocol	
16				
17		20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	15
18				
19		20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any	14-15
20			statistical methods to handle missing data (eg, multiple imputation)	
21				
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23	Methods: Monitoring			
24				
25	Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of	NA
26			whether it is independent from the sponsor and competing interests; and reference to where further details	
27			about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not	
28			needed	
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30		21b	Description of any interim analyses and stopping guidelines, including who will have access to these	NA
31			interim results and make the final decision to terminate the trial	
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34	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse	15
35			events and other unintended effects of trial interventions or trial conduct	
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37	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent	NA
38			from investigators and the sponsor	
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41	Ethics and dissemination			
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1	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	15
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4	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	15
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8	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	15
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11		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	NA
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14	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	15
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18	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	17
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21	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	9
22				
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24	Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	NA
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27	Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	15
28				
29		31b	Authorship eligibility guidelines and any intended use of professional writers	15
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31		31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	NA
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37	Appendices			
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1	Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	Patient and Parent informed consent + Supplement (CE _{EV} standardised session protocol)
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9	Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	NA

*It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items. Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons “Attribution-NonCommercial-NoDerivs 3.0 Unported” license.