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WASHINGTON UNIVERSITY IN ST. LOUIS  
Department of Psychological and Brain Sciences

Adapting Radically Open Dialectical Behavior Therapy (RO-DBT) for Adolescents:  
Preliminary Testing of Mechanisms of Change  
by  
Molly Fennig

A thesis presented to  
Washington University in St. Louis  
in partial fulfillment of the  
requirements for the degree of Master of Arts

May 2023

St. Louis, Missouri

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Molly Fennig

*Washington University in St. Louis*

*May 2023*

## ABSTRACT OF THE THESIS

Adapting Radically Open Dialectical Behavior Therapy (RO-DBT) for Adolescents:

Preliminary Testing of Mechanisms of Change

by

Molly Fennig

Master of Arts in Psychological and Brain Sciences

Washington University in St. Louis, 2023

Professor Deanna Barch, Co-Chair

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Background: Overcontrol is a phenotype characterized by inflexibility, perfectionism, and a need for control or structure, which increases risk for disorders such as anorexia nervosa, social anxiety, and obsessive-compulsive disorder. Given high comorbidity and limited efficacy of current treatments for these disorders, Radically Open Dialectical Behavior Therapy for adolescents (RO DBT-A) attempts to improve outcomes by targeting overcontrol as a transdiagnostic mechanism. This study aimed to test preliminary efficacy of telehealth-delivered RO DBT-A in targeting overcontrol as a mechanism of psychopathology in a heterogeneous clinical sample.

Method: Participants were female adolescents (ages 13-21; 83% white; 80% non-Hispanic/Latino) who presented with elevated overcontrol. RO DBT-A was provided as the sole psychological treatment for those who wanted it (n = 13) over 16 weeks via skills group and individual sessions. Therapy was delivered via online platform due to the study being during the 2020 COVID pandemic. Non-treatment seeking participants served as controls (n = 7).

Outcomes measured at baseline and post-treatment included psychiatric symptoms and overcontrol self-report, and neural responses to reward (wins/losses) and errors via electroencephalogram (EEG).

Results: There were significant improvements in depression ( $t(10.3) = -1.78, p = 0.01$ ) and quality of life ( $W = 75, p = 0.02$ ) in the RO DBT group compared to the control group. Testing change within the RO DBT group from baseline to post treatment demonstrated significant improvements in overcontrol ( $t(12) = 2.76, p = 0.04$ ), anxiety ( $t(12) = 2.91, p = 0.04$ ), depression ( $V = 82.5, p = 0.04$ ) and quality of life ( $t(12) = -3.01, p = 0.04$ ), even after FDR correction. No change in EEG based neural markers was found, although the study was underpowered to detect neural changes.

Discussion: This study provides preliminary evidence for efficacy of telehealth-delivered RO DBT-A in targeting behavioral overcontrol, decreasing symptomology, and importantly, improving quality of life, in a heterogenous clinical sample of teens. Future studies should employ randomized design and examine neural markers in larger sample sizes.

Key words: radically open dialectical behavior therapy, adolescents, EEG, case series



## **Adapting Radically Open Dialectical Behavior Therapy (RO-DBT) for Adolescents:**

### **Preliminary Testing of Mechanisms of Change**

Self-control consists of delaying gratification and inhibiting urges in order to regulate emotions and engage in goal-directed behavior (Baumeister et al., 2007). Self-control develops in childhood and is both adaptive and protective against onset of psychopathology in youth (Moffitt et al., 2011). As such, a lack of self-control (i.e., undercontrol) predicts disorders such as borderline personality disorder and alcohol use disorders, over and above similar constructs such as impulsivity (Johnson et al., 2017). However, control is conceptualized on a spectrum, with individuals towards the middle showing the most resiliency (Lynch, 2018; Vanderbleeck & Gilbert, 2018). Therefore, those with too much self-control (i.e., overcontrol) are purportedly at increased risk for pathology as well (Vanderbleeck & Gilbert, 2018).

Overcontrol is more than just elevated self-control though, it is a transdiagnostic cognitive control and emotional processing style associated with heightened performance monitoring (Gilbert, Perino, et al., 2020), self-restriction, need for structure, checking behaviors, high concern for mistakes, perfectionism, anxious apprehension and cognitive inflexibility/rigidity (Egan et al., 2011; Gilbert, Barch, et al., 2020; Lynch et al., 2020; Zucker et al., 2007). Overcontrol is thought to become stable by age 5 (Eisenberg et al., 2010), demonstrates stability across the lifespan (Asendorpf et al., 2001; Chapman & Goldberg, 2011), and is heritable (Manoach & Agam, 2013).

Overcontrol has repeatedly been associated with social impairment, such as loneliness and isolation (Eisenberg et al., 2000, 2010; Gilbert et al., 2019; Lynch, 2018). Overcontrol is also implicated in a range of psychiatric disorders, particularly anorexia nervosa (AN; Isaksson et al., 2021), but also including some forms of social anxiety disorder, general anxiety presentations

(Gilbert et al., 2022; Gilbert, Perino, et al., 2020; Henderson et al., 2015), obsessive-compulsive disorder (Gilbert et al., 2018, 2022), and treatment-resistant depression (Lynch et al., 2020).

These disorders are often characterized by cognitive set-shifting difficulties (i.e., inflexibility; Chamberlain et al., 2021; Miles et al., 2020), altered reward responding (Haynos et al., 2021; Koch et al., 2018) and social functioning deficits (Jansen et al., 2020; Kerr-Gaffney et al., 2018). Of note, these disorders are commonly comorbid with each other, hinting at underlying mechanisms, such as overcontrol, driving associative relationships.

Overcontrol in youth can be indexed with behavioral self-reported measures (Gilbert, Barch, et al., 2020; Lenz et al., 2021). Further, overcontrol demonstrates associations with aberrant neural error processing (Gilbert et al., 2022; Gilbert, Perino, et al., 2020). In fMRI, overcontrol has been shown to be associated with reduced neural response to errors, relative to correct responses, even after controlling for anxiety (Gilbert, Perino, et al., 2020). Using electroencephalogram (EEG) based recordings, overcontrol has been associated with the error-related negativity (ERN), an event related potential (ERP) occurring as a negative deflection after a behavioral error (Holroyd & Coles, 2002). The ERN is associated with overcontrol (Gilbert et al., 2022), increases risk for social anxiety disorder (Henderson et al., 2015), is particularly elevated in OCD (Riesel et al., 2019), and has been speculated to be an endophenotype across psychiatric disorders of overcontrol (Manoach & Agam, 2013; Riesel et al., 2015). Similarly, the error positivity (PE) is an ERP occurring as a positive deflection after the ERN (Falkenstein et al., 1991; Overbeek et al., 2005). Whereas the ERN may capture immediate, unconscious responding to errors, the Pe may reflect conscious error processing (Nieuwenhuis et al., 2001). Therefore, the ERN and Pe are overlapping, yet distinct, indicators of error-monitoring. Altered neural reward processing is also implicated in psychopathology related

to overcontrol (Haynos et al., 2021; Koch et al., 2018) and blunted reward responding is theorized to be characteristic of overcontrol (Lynch, 2018). The reward positivity (RewP) is an EEG recorded neural marker of response to rewards, relative to negative outcomes (Proudfit, 2015). The RewP is blunted in disorders of dysfunctional reward sensitivity, such as depression (Clayson et al., 2020; Liu et al., 2014) and heightened in social anxiety disorder (Nelson & Jarcho, 2021), but has not been studied in other disorders of overcontrol, such as anorexia and OCD.

### **Treatment for disorders of Overcontrol**

Across disorders of overcontrol, treatment remains suboptimal. There is not currently one empirically proven superior treatment for AN (Watson & Bulik, 2013). Even when treated in adolescence, end-of-treatment remission rates range from 23–33%, with only one third of this sample remaining in remission four years later (Le Grange et al., 2014, 2016; Lock et al., 2010). Similarly, cognitive-behavioral therapy (CBT) has the most empirical support for treating anxiety disorders, but based on meta-analyses, 41% of youth do not achieve remission following CBT (James et al., 2020). High comorbidity of disorders of overcontrol (e.g., OCD, anxiety, and eating disorders) suggests the possibility of underlying, shared mechanisms (Schaumberg et al., 2021; Williams et al., 2022). Therefore, treatments that target transdiagnostic mechanisms may be more effective by addressing development and maintenance factors underlying high comorbidity (Insel et al., 2010; Sauer-Zavala et al., 2017).

### **Radically Open Dialectical Behavior Therapy (RO DBT)**

Radically Open Dialectical Behavior Therapy (RO DBT) is a novel psychosocial treatment that directly targets overcontrol in treatment (Lynch, 2018; Lynch et al., 2020). RO DBT utilizes dialectical principles and a behavioral framework focused on increasing openness

and flexibility during new experiences and feedback, and increasing social connectedness by targeting social communication styles. Additionally, RO DBT targets maladaptive aspects of overcontrol related to overly detail-focused and cautious behavior, rigid and rule-governed behavior, inhibited and disingenuous emotional expression, distant and aloof relationships, and social comparisons.

The most rigorous study of RO DBT so far examined adult patients with treatment resistant depression, another disorder of overcontrol (Lynch et al., 2020). The multi-site randomized controlled trial tested RO DBT versus treatment as usual (TAU) with RO DBT showing significantly higher remission rates at all time points (e.g., 23% partial remission at 7-months post treatment for RO DBT versus 6% for TAU), increased psychological flexibility and emotional coping, and a large effect size for decreasing symptoms. Further, 86% of participants in this study had at least one additional DSM-IV disorder, including other disorders of overcontrol, demonstrating efficacy for individuals with comorbid psychopathology. Preliminary research of RO DBT on AN has also shown significant improvements in eating disorder symptoms, quality of life, and distress (Chen et al., 2015; Lynch et al., 2013), as well as constructs related to overcontrol such as social connectedness and reward responsivity (Baudinet et al., 2020), although these studies did not have control conditions. While RO DBT has mostly been tested in individual psychiatric presentations, it was designed to target overcontrol transdiagnostically. As such, RO DBT has been compared to treatment as usual (TAU) in heterogeneous populations of overcontrolled psychopathology (Baudinet et al., 2021; Keogh et al., 2016). Although group assignments weren't randomized, RO DBT showed greater reductions in pathology, improvements in coping skills, and feeling safe in social environments, with medium to large effects (Keogh et al., 2016) and reductions in transdiagnostic eating disorder,

depression, and self-harm symptoms, with medium to large effects when adapted for adolescents (Baudinet et al., 2021). Importantly, the Baudinet et al., (2021) study showed changes in underlying constructs related to overcontrol such as increased reward processing and social connectedness, also with medium to large effects (Baudinet et al., 2021), showing both efficacy and engagement of hypothesized mechanisms of overcontrol (i.e., social connectedness and reward responsivity) at a behavioral level. However, whether RO DBT is able to target overcontrol at the neural level is unknown.

### **Current Study**

The current study aimed to test preliminary efficacy of RO DBT delivered over telehealth in decreasing not only transdiagnostic psychiatric symptoms, but also behavioral and neural overcontrol and hypothesized mechanisms of overcontrol. The intervention was delivered via telehealth due to the COVID-19 pandemic given that the study took place between 2020-2021. The sample included heterogeneous clinical presentations and the therapy was provided as a non-randomized case series. The examination of efficacy included determining if behavioral and neural (ERN, RewP, and PE) overcontrol were engaged as mechanisms of psychopathology. To do this, we first examined psychiatric symptom and behavioral and neural changes with intent-to-treat analyses, hypothesizing that those in the RO DBT group would show significantly more improvement across psychiatric symptom (depression, anxiety, eating disorder) presentations, quality of life, social functioning, and in behavioral (self-reported overcontrol and reward responding) and neural (ERN, RewP, and PE) indicators of overcontrol, compared with controls. Next, we looked at pre/post changes within the RO DBT group only, hypothesizing that there would be significant symptom reduction. Finally, we looked at the relationship between possible

neural mechanisms (ERN and RewP) and symptom change within the RO DBT group, testing whether baseline neural indicators would predict symptom change.

## **Method**

### **Participants**

Female adolescents between the ages of 13-21 were recruited if they presented with elevated psychiatric impairment and elevated maladaptive overcontrol using the Adolescent Over- and Under-control Trait Measure (A-OUT'M; Lenz et al., 2021), the Overcontrol in Youth Checklist Adolescent version (OCYC; unpublished draft) and clinician judgment. Given small sample size not allowing for statistical power to test sex effects, only female adolescents were included. Adolescents who were either not in treatment or had finished prior treatments (e.g., Family Based Therapy for anorexia), were deemed medically stable, and were seeking additional treatment were invited to participate. Treatment was provided to those who wanted it, as a non-randomized case series. Adolescents who chose the control condition could seek other treatment, or no treatment, and came back after 4 months for follow-up measures. Those in the treatment condition were able to continue ongoing medication management, but transitioned to RO DBT for adolescents (RO DBT-A) as the sole psychosocial treatment provided, which was offered at no cost. Exclusion criteria included significant developmental delays, seizure or other major neurological disorder, or severe head injury. Individuals were assigned to treatment or control conditions as a non-randomized case series where treatment was given to participants who wanted it, until treatment recruitment ended.

The sample included 20 adolescent females ( $M_{\text{age}} = 16.74 \pm 1.89$ ) who received RO DBT-A in treatment ( $n = 13$ ) and control ( $n = 7$ ) groups. The majority of individuals self-identified as

white (75%), Non-Hispanic/Latino (80%), and were taking psychiatric medication (60%). Demographic information is displayed in Table 1 by group, including age, weight, height, BMI z-score, race, ethnicity, and psychiatric medication use. The only significant difference between groups was age,  $t(27.7) = 4.93, p < 0.001$ , with the treatment group being significantly younger. As such, age was controlled for in regression analyses.

### **Behavioral Overcontrol**

Adolescents completed the Overcontrol in Youth Checklist–Adolescent (OCYC-A; Gilbert et al., 2019) and the Youth Over- and Under-Control (YOU-C) measure (Lenz et al., 2021) to measure behavioral overcontrol, once before and once after treatment. The OCYC is an 18-item measure with items rated as yes or no (Cronbach’s  $\alpha = 0.79$ ). The OCYC includes items such as “frequently compare my abilities with that of peers and siblings” and “gets frustrated when I can’t seem to get it right the first time”. The YOU-C is a 25-item measure, with 14 items on the overcontrol subscale ( $\alpha = 0.88$ ), rated from 0 (“not at all”) to 6 (“extremely”). Adolescents rated how well personality trait words (e.g., Compliant, Self-Controlled, and Patient for Reward) are characteristic of them.

### **Behavioral Reward Responding**

Behavioral reward responding was indexed before and after treatment using the Temporal Experience of Pleasure Scale (TEPS), including the anticipatory and consummatory subscales (Gard et al., 2006). The TEPS is an 18-item measure, rated from one (“very false for me”) to six (“very true for me”;  $\alpha = 0.89$ ). Examples of items include “I look forward to a lot of things in my life” (anticipatory) and “I enjoy taking a deep breath of fresh air when I walk outside” (consummatory).

### **Self-Reported Psychiatric Symptoms and Functioning**

Adolescents completed self-reports of psychiatric symptoms associated with overcontrol pre- and post-treatment. This included the Eating Disorder Examination-Questionnaire (EDE-Q) for eating disorder pathology for the last 28 days, as a 36-item, 7-point scale (Fairburn & Beglin, 1994). The resulting global score ( $\alpha = 0.83$ ), and four subscales, are comprised of item averages which, when over 4, indicate clinically significant eating pathology.

Symptoms of anxiety were measured with the Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1998). The SCARED is a 41-item scale ( $\alpha = 0.90$ ) rated from zero (“Not True or Hardly Ever True”) to two (“Very True or Often True”). Summed total scores ( $\alpha = 0.90$ ) over 25 indicate clinically significant anxiety.

Depression was measured with the Child Depression Inventory (CDI; Kovacs & Beck, 1977). The 27-item scale is rated from 0 to 2, and summed to create a total score. The suicidality question was omitted, yielding 26 questions. The T-score of the total score was used ( $\alpha = 0.92$ ).

Participants also completed measures of functional and social impairment using the Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire (PQ-LES-Q; Endicott et al., 2006) and the Social Connectedness Scale (SCS; Lee & Robbins, 1995). The PQ-LES-Q is a 15-item scale, with items rated from one (“Very Poor”) to six (“Very Good”) where the first 14 items are summed for a total score and the last item is a self-reported global measure ( $\alpha = 0.93$ ). Higher scores indicate higher satisfaction and enjoyment. The SCS is an 8-item measure, rated from one (“Agree”) to six (“Disagree”) and summed, with higher scores indicating more social connectedness ( $\alpha = 0.91$ ). An example item from the SCS is “I feel so distant from people”.

While other measures were administered only pre- and post-treatment, adolescents’ height and weight were taken at every individual therapy session to monitor eating disorder presentations and ensure weight and medical stability. BMI was converted to z-scores using



CDC growth charts (Kuczmarski, 2000), given that z-scores have been proposed as more valid than overall BMI in adolescents (Inokuchi et al., 2011). Age, race, ethnicity, and current psychiatric medication use were also collected at baseline.

## **Neural Assessments**

### ***EEG recording***

BrainVision ActiChamp 32 channel active channel amplifier system (BrainVision LLC) was used to record continuous EEG along with a 32-channel, 10/20 system act-iCAP electrode cap. Additional electrooculogram (EOG) electrodes were placed laterally to the eyes to record horizontal EOG and two electrodes placed above and below the left eye to record vertical EOG and to detect blinks and eye movements. EEG was continuously recorded at 500 Hz and referenced online to electrode Cz. Offline processing used Brain Vision Analyzer software (Brain Products, Germany) to re-reference to the average of TP9 and TP10 (adjacent to the mastoids), band-pass filter from 0.1 to 30 Hz, and correct blinks and movements using Gratton et al (1983) procedures. Semi-automatic rejection of physiological artifacts including allowing maximum voltage steps of 50  $\mu$ V, maximum absolute voltage difference of 175  $\mu$ V within 400ms and minimum allowed activity of .5  $\mu$ V within 100ms.

### ***Neural indicators of Error Monitoring***

Adolescents completed a flanker task while undergoing EEG recordings. In this task, adolescents had to indicate which direction an arrow was pointing when distracting arrows flank the stimuli. The ERN was measured on error trials. Response locked ERPs were averaged separately for correct and error trials with a baseline correction from -400 to -200 ms before response. To measure the ERN, mean amplitude was measured -50 to 100 ms prior to and following the response. After visual inspection, the ERN was calculated at Cz, a commonly used

location in ERN studies (Clark et al., 2019). Linear regression was used to create residualized ERN scores, allowing for examination of errors after partialing out the effect of correct responses (Meyer et al., 2017). Behavioral reaction time and errors were also recorded.

The Pe is measured at centroparietal regions, often from Cz and Pz electrodes (Overbeek et al., 2005). Therefore, the Pe was measured separately at both Cz and Pz. The mean amplitude was measured from 150 to 450 ms following the response on the flanker task. Correct trials were subtracted from error trials. Given that there is less literature on the Pe compared to the ERN, included analyses were exploratory.

### ***Neural indicator of Reward Responding***

Participants played a modified guessing game, the Doors Task (Proudfit, 2015), while undergoing EEG recordings. Two doors were presented on the computer screen with one containing a prize. Participants hit a button to select a door. If guessed correctly, a green arrow pointing up indicated they won points. If incorrect, a red arrow pointing down indicated they lost points. In all, 30 win and 30 loss trials were administered. The RewP is a feedback-locked ERP, baseline corrected to 200ms prior to feedback, and is assessed by subtracting the negative feedback (loss) neural responses from the positive feedback (win) trials in the 200-300ms time window. The RewP is usually measured at the FCz electrode, or the Fz electrode for EEG caps without FCz, like the one used in this study (Glazer et al., 2018; Proudfit, 2015).

### **Treatment**

RO DBT-A is a modified protocol of the full RO DBT treatment for adolescents. RO DBT-A includes 16 weekly 1.5-hour adolescent group (“skills”) sessions. The skills group allowed rolling admission. Adolescents also participated in weekly 1-hour individual therapy sessions for the duration of the 16 weeks. Therapy included components such as completion of

weekly diary cards to track behaviors, thoughts, and emotions, application of skills learned in class, and conducting in-session chain analyses of problematic behaviors. Identical to standard RO DBT, RO DBT-A treatment themes include 1) hyper-detail-focused and overly cautious behavior, 2) rigid and rule-governed behavior, 3) inhibited and disingenuous emotional expression 4) distant and aloof social connectedness and relationships and 5) high social comparisons and envy. Two master's level and one PhD level therapist provided therapy, all of whom were intensively trained in RO DBT. Therapists underwent weekly peer supervision as well as monthly supervision from the developer of RO DBT (Dr. Lynch) using videorecorded telehealth sessions.

## **Analyses**

### ***Baseline Group Differences***

First, normality assumptions were checked using Shapiro-Wilk tests. Then, unpaired *t*-tests were used for age and height to check for baseline differences between the treatment and non-treatment groups. Weight and BMI z-scores were not normally distributed so Wilcoxon signed-rank tests were used. Difference across groups in terms of race, ethnicity, and use of psychiatric medication (yes/no) were assessed with chi squared tests.

### ***Intent-to-Treat Analyses***

In order to compare pre/post changes between the treatment group and the clinical control group, intent-to-treat analyses were conducted. If normality assumptions were met via Shapiro-Wilk tests, unpaired *t*-tests were used to evaluate significance of differences between changes in symptoms for the treatment group, and changes in symptoms for the control group. Otherwise, Wilcoxon signed-rank tests were used. Effect sizes were calculated with Cohen's *D* and pooled variances.

### ***Pre/Post-Treatment Analyses for the Treatment Group***

Shapiro-Wilk tests were conducted to check for normality. If normality assumptions were met, paired t-tests were used to evaluate significance of differences between baseline and post-treatment for the treatment group only. Otherwise, Wilcoxon signed-rank tests were used. Results were FDR corrected, and Cohen's D paired-sample effect sizes calculated. FDR correction was used since these analyses were more secondary to the intent-to-treat tests.

### ***Neural Measure Associations with Symptom Changes***

First, regressions were run to see if the baseline Flanker Cz ERN residual or baseline Fz RewP predicted change in symptoms for the treatment group. Symptoms that significantly changed pre- to post-treatment for the treatment group were included in these analyses. Second, separate linear regressions were run including the ERN residual as a predictor of changes for each outcome (YOU-C overcontrol, OCYC overcontrol, quality of life, depression, and anxiety) controlling for age and number of RO DBT sessions. Similarly, separate linear regressions were run with the baseline RewP as a predictor of changes in each outcome (YOU-C overcontrol, OCYC overcontrol, quality of life, depression, and anxiety) controlling for age and number of RO DBT sessions. Regressions were not run for Pe measures, given that Pe analyses were exploratory.

### ***Power Analyses***

Power analyses were conducted to determine the sample size needed to detect an effect, if one was present, based on published effect sizes. We used 80% power and an alpha of 0.05. For intent-to-treat analyses, two sample tests were used. Non-RO DBT treatment studies of Parent-Child Interaction Therapy-Emotion Development for childhood depression and attention training for OCD both found partial eta-squared effect sizes of 0.07 (Cohen's D = 0.55) for changes in

the RewP and ERN respectively (Barch et al., 2020; Tan et al., 2021). This corresponds to an N of 53 per group needed to detect an effect. Given our sample sizes of 13 in the treatment group and 7 in the control group, we were underpowered to detect neural effects.

For pre/post analyses, paired tests were used. Previous RO DBT studies have found Cohen's D effect sizes for TEPS reward/pleasure ranging from 0.42 – 0.79, corresponding to Ns of 15-47 needed to detect an effect (Baudinet et al., 2020, 2021). These studies have also found Cohen's D effect sizes for the SCS ranging from 0.48 – 1.03 (Ns of 10-37), Cohen's D for depression ranging from 0.41 - 0.71 (Ns of 18-49), and Cohen's D for the EDE-Q of 1.06 (N of 10). Given our treatment sample size of 13, we could have been adequately powered to detect changes in SCS social connectedness and EDE-Q eating pathology. However, it is possible that we didn't have enough power for TEPS reward/pleasure or depression, although the depression measure from the literature was the MFQ whereas we used the CDI.

## **Results**

### ***Baseline Characteristics & Treatment Completion***

As shown in Table 2, on average participants were similar to other youth community samples for general overcontrolled personality (YOU-C; Lenz et al., 2021) and similar in maladaptive overcontrolled personality aspects to youth with anxiety disorders (OCYC; (Gilbert, Perino, et al., 2020). Participants were also similar to clinical samples for TEPS consummatory and anticipatory pleasure, for major depression and OCD respectively (Li et al., 2019). Additionally, clinical significance was met for SCARED anxiety ( $M = 40.2 \pm 12.9$ ; cutoff = 25), CDI depression ( $M_{Total\ Score\ T-value} = 68.5 \pm 15.5$ ; cutoff = 65), and SCS social connectedness ( $M = 24.5 \pm 9.3$ ). PQ-LES-Q quality of life was low to average (Anderson et al., 2022). Although

across the sample, clinically significant eating disorder pathology was not surpassed ( $M = 1.76 \pm 1.38$ , cutoff = 2.8), five individuals in the treatment group (38%) and three in the control group (43%) had clinically significant eating disorder psychopathology on the EDE-Q. In the treatment group, 11 individuals (79%) had clinically significant depression based on CDI T-scores, and 11 individuals (79%) had clinically significant anxiety based on the SCARED.

Six participants (46%) did not complete all 20 RO DBT-A treatment sessions, while the remaining seven did. Therapist assignment was not significantly associated with drop out (2 participants dropped from one therapist, 3 from another, and the third therapist had a participant drop after switching to them). Ten participants completed at least half of the sessions (77%). The average number of sessions completed was  $15.62 \pm 5.74$ . Reasons for dropping out included difficulty finding time to schedule sessions ( $n = 2$ ), thinking therapy was too demanding or stressful ( $n = 1$ ), not identifying as overcontrolled ( $n = 1$ ), not thinking the therapist “was a good fit” after getting critical feedback ( $n = 1$ ), and not wanting to change behaviors or “lose control” ( $n = 1$ ). Of note, there were no significant differences on any baseline variables between those who completed all 20 sessions and those who did not.

### ***Intent-to-Treat Analyses***

For intent-to-treat analyses, only depression ( $t(10.3) = -1.78$ ,  $p = 0.01$ ) and quality of life ( $W = 75$ ,  $p = 0.02$ ) significantly improved more in the treatment group compared to the control group. Behavioral measures of pleasure/reward, eating disorders, anxiety, and social connectedness, as well as neural RewP, ERN, and Pe were not significant (Table 3).

### ***Pre/Post-Treatment Analyses for the Treatment Group***

For pre-post analyses only examining change within the treatment group, even after FDR corrections there were significant decreases in overcontrol ( $t(12) = 2.76$ ,  $p = 0.04$ ), anxiety ( $t(12)$

= 2.91,  $p = 0.043$ ), and depression ( $V = 82.5$ ,  $p = 0.04$ ) and significant increases in quality of life ( $t(12) = -3.01$ ,  $p = 0.04$ ; Table 4) from baseline to post-treatment. Again, we found no significant change in neural error or reward responding within the treatment group.

### ***Neural Measure Associations with Symptom Changes***

Lastly, examining baseline neural functioning and associations with change in symptoms, there were no significant relationships between baseline Flanker Cz ERN residual and change in symptoms (YOU-C overcontrol, OCYC overcontrol, quality of life, depression, and anxiety) for the treatment group when controlling for age and number of treatment sessions (Table 5).

Similarly, there were no significant relationships between baseline Fz RewP and change in symptoms (YOU-C overcontrol, OCYC overcontrol, quality of life, depression, and anxiety) for the treatment group when controlling for age and number of treatment sessions (Table 6).

## **Discussion**

While RO DBT holds promise as a transdiagnostic treatment, its ability to target behavioral and neural overcontrol in a heterogenous clinical sample remains unclear. Therefore, the present study aimed to preliminarily examine efficacy of a telehealth-delivered RO DBT adaptation for adolescents that targets overcontrol in a heterogeneous clinical sample. Compared to the non-treatment group, adolescents receiving RO DBT-A had significantly improved quality of life and depression. Within the treatment group, significant improvements were seen for overcontrol, anxiety, depression, and quality of life from baseline to post-treatment. There were no significant changes in neural ERN, RewP, or Pe for the treatment group in either analysis. Similarly, there were no significant relationships between baseline ERN and changes in

symptoms, or baseline RewP and changes in symptoms, when controlling for age and number of RO DBT sessions.

As previously mentioned, compared with controls, decreases in depression, and increases in quality of life were demonstrated for the RO DBT group. As such, our hypothesis that those in the treatment group would show significantly more improvement than controls is supported for these measures. Indeed, given the chronic nature of many disorders of overcontrol, including low to moderate remission rates for eating and anxiety disorders after CBT treatment (James et al., 2020; Le Grange et al., 2014, 2016; Lock et al., 2010), improvements in quality of life may be especially important as symptoms either wax and wane over the life course. Additionally, assessing change from pre- to post-treatment within the RO DBT group, significant changes were found for depression and quality of life again, as well as decreases in anxiety. Therefore, both the intent-to-treat and pre/post changes support the findings of a number of previous RO DBT studies that have also shown decreased depression (Baudinet et al., 2021; Lynch et al., 2020) and improved quality of life (Lynch et al., 2013) following treatment. Although previous studies have demonstrated changes related to social functioning and behavioral reward responding (Baudinet et al., 2020; Lynch, 2018), we did not see significant improvements in these two measures. This may be due to the measure of social connectedness capturing broad feelings of human connection, rather than the strength of specific relationships. This is especially worth noting given a number of participants anecdotally reported more fulfilling friendships following therapy. Second, although we did not see changes in reward responding, there was a trend in increasing reward anticipation and consummation with moderate effect sizes.

A main focus of the current study was to test whether RO DBT-A engages behavioral and neural overcontrol as a mechanistic target. Although no intent-to-treat differences emerged in



behavioral or neural overcontrol across groups, we did demonstrate a significant within RO DBT-A decrease in behavioral overcontrol. This is in line with previous research demonstrating engagement of aspects related to behavioral overcontrol, namely reward responsivity, social connectedness, and cognitive flexibility, with RO DBT (Baudinet et al., 2021), although specific measures of overcontrol were not included.

The current study's small sample size and lack of randomization prevent firm conclusions from being drawn about the lack of change in neural indicators after treatment. However, previous research has similarly demonstrated lack of change in the ERN following psychotherapy, even in the presence of significant symptom change (Gorka et al., 2018; Ladouceur et al., 2018). Some have taken this as indication that the ERN is a biomarker that is less pervious to change (Olvet & Hajcak, 2008). One study that did show changes in the ERN, following attention bias modification training for OCD, but only demonstrated an attenuated ERN in emotional Flanker tasks (Tan et al., 2021). Thus, the lack of ERN change seen in this study with a non-emotional Flanker task is consistent with previous research. Further, the hypothesis that baseline ERN would predict symptom change was not supported. This is in contrast to previous research that demonstrated a larger ERN was a moderator of treatment response for CBT for anxiety disorders (Gorka et al., 2018), although the ERN has not been extensively studied as a treatment moderator in transdiagnostic, or non-anxiety, clinical samples. Additionally, we didn't see change in the RewP following RO DBT, in contrast to previous studies demonstrating changes in RewP after parent-child interaction treatment for childhood depression (Barch et al., 2020). However, it is possible that the lack of change could be due to differences in treatment types or clinical presentation (i.e., the entire sample was not depressed). For instance, although behavioral change has been demonstrated for reward processing following

RO DBT (Baudinet et al., 2020), RO DBT focuses less on reward processing and more on errors, perfectionism, and rigidity. On the other hand, baseline RewP failing to predict psychotherapy treatment change is consistent with other studies (Barch et al., 2020; Burkhouse et al., 2018). Finally, similar to other studies looking at CBT for OCD and trichotillomania (Hajcak, 2006) and unspecified treatment for major depressive disorder (Schrijvers et al., 2009), we saw no significant changes in the Pe after therapy, either independently or when compared to controls.

Clinically, it is important to note that RO DBT for adolescents with heterogeneous clinical presentations is feasible via telehealth, however it comes with some considerations. The 46% dropout rate of this study was higher than other RO DBT trials (14.3 – 28%; Baudinet et al., 2021; Lynch et al., 2013, 2020), which may be due to the use of telehealth, the study being conducted during the early phase of the COVID-19 pandemic when other factors (i.e., one's safety and physical health) took precedence over targeting maladaptive overcontrol, or other factors such as small sample size. However, 77% of participants completed at least half of the sessions. Interestingly, almost all reasons for drop-out were consistent with overcontrolled behavior, such as being too overscheduled or not wanting to lose control by engaging in behavior change. As such, future studies looking at targeting overcontrol as both a mechanism of psychopathology and a potential barrier to treatment may be warranted. Given the chronicity and high comorbidity of disorders of overcontrol, being able to target multiple, commonly comorbid psychiatric illnesses with one treatment may be especially important in adolescence. Such early, transdiagnostic treatment may offer not just treatment of current symptomology, but also long-term therapeutic change and prevention.

## **Limitations**

It is important to note that this study was done as a case series, meaning there was no randomization to groups. As such, we cannot rule out the effects of participant choice. Other limitations include the aforementioned small sample size. While an all-female, mostly white sample is commonly seen in clinical samples, particularly for eating and anxiety disorders (Burnette et al., 2022; Carpenter et al., 2018), and given that all-female participants were necessary for power in this study, it is unclear how well these results would generalize to other populations, such as males and more diverse demographic participants. Lastly, although we did find change in behavioral overcontrol, outcomes were only assessed pre and post treatment (not mid-treatment), and as such, we are not able to make mechanistic claims about change.

### **Conclusions**

This study provides preliminary evidence for efficacy of telehealth-delivered RO DBT-A in targeting behavioral overcontrol, decreasing transdiagnostic symptomology, and importantly, improving quality of life, in a heterogenous clinical sample of teens characterized by overcontrol. Future studies should employ randomized design and utilize larger sample sizes to further explore neural mechanistic change in the context of RO DBT-A.

**Table 1***Participant demographics*

|                   | Full sample (n = 20)  | Treatment (n = 13)   | Non-treatment (n = 7)  |
|-------------------|---|--|--|
| Age (years)       | 16.74 ± 1.89  | 15.79 ± 1.22 **  | 18.51 ± 1.63 **  |
| Height (inches)   | 64.18 ± 2.26  | 64.28 ± 2.13   | 64.00 ± 2.66   |
| Weight (lbs)      | 123 ± 12.95   | 124.26 ± 11.87   | 120.66 ± 15.49   |
| BMI z-score       | -0.01 ± 0.77  | 0.18 ± 0.74  | -0.42 ± 0.74   |
| Race              | 1 (5%) Mixed<br>1 (5%) Asian<br>15 (75%) White<br>3 (15%) Did Not Say         | 1 (8%) Mixed<br>1 (8%) Asian<br>8 (62%) White<br>3 (23%) Did Not Say | 0 (0%) Mixed<br>0 (0%) Asian<br>7 (100%) White<br>0 (0%) Did Not Say |
| Ethnicity         | 16 (80%) Non-Hispanic/Latino<br>1 (5%) Hispanic/Latino<br>3 (15%) Did Not Say | 10 (77%) Non-Hispanic/Latino<br>3 (23%) Did Not Say                  | 6 (86%) Non-Hispanic/Latino<br>1 (14%) Hispanic/Latino               |
| Taking Psych Meds | 12 (60%) Yes  | 9 (69%) Yes  | 3 (43%) Yes  |

*Note:* Age was significantly different between the treatment and non-treatment groups,  $t(27.7) = 4.93, p < 0.001$ .

**Table 2***Baseline behavioral self-report scores*

|                             | Clinical cutoff or comparison                         | Full sample | Treatment   | Non-treatment |
|-----------------------------|---|-------------|-------------|---------------|
| <b>Overcontrol</b>          |   |             |             |               |
| YOU-C                       | 60.61 ± 12.98 <sup>1</sup>                            | 53.0 ± 13.8 | 52.6 ± 15.2 | 53.5 ± 13.4   |
| OCYC                        | 9.12 ± 4.60 <sup>2</sup>                              | 12.5 ± 2.9  | 12.1 ± 3.8  | 12.8 ± 2.1    |
| <b>Pleasure/Reward</b>      |   |             |             |               |
| TEPS – Ant                  | 33.03 ± 6.88 <sup>3</sup>                             | 34.3 ± 8.6  | 31.7 ± 9.2  | 36.4 ± 7.7    |
| TEPS – Cons                 | 31.06 ± 6.62 <sup>3</sup>                             | 35.3 ± 8.3  | 31.8 ± 9.6  | 38.2 ± 5.9    |
| <b>Psychiatric Symptoms</b> |   |             |             |               |
| EDE-Q                       | ≥ 2.8 <sup>4</sup>                                    | 1.76 ± 1.38 | 1.79 ± 1.53 | 1.73 ± 1.29   |
| SCARED                      | ≥ 25  | 40.2 ± 12.9 | 36.4 ± 12.0 | 43.3 ± 13.0   |
| CDI T                       | ≥ 65  | 68.5 ± 15.5 | 73.4 ± 17.2 | 64.4 ± 13.0   |
| PQ-LES-Q                    | low (< 45), average (46–58), high (> 59) <sup>5</sup> | 46.0 ± 9.7  | 43.8 ± 10.8 | 47.9 ± 8.5    |
| SCS                         | 93.14 ± 14.49   | 24.5 ± 9.3  | 25.6 ± 10.3 | 23.6 ± 8.7    |

*Note:* OCYC = Overcontrol in Youth Checklist–Adolescent; YOU-C = Youth Over- and Under-Control measure; TEPS = Temporal Experiences of Pleasure Scale; Ant = Anticipatory; Cons = Consummatory; EDE-Q = Eating Disorder Examination – Questionnaire; SCARED = Screen for Child Anxiety Related Disorders; CDI T = Child Depression Inventory T-score; PQ-LES-Q = Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; SCS = Social Connectedness Scale.

<sup>1</sup> = Lenz et al., 2021 – non-clinical youth community sample; <sup>2</sup> = Gilbert, Perino, et al., 2020 – adolescents ages 9-12 with anxiety disorders; <sup>3</sup> = Li et al., 2019 – young adults with Ant in OCD

sample and Cons in major depressive disorder sample; <sup>4</sup> = Mond et al., 2008, 2008; <sup>5</sup> = Anderson et al., 2022

**Table 3***Intent to treat analyses*

| <b>Symptom Self-Reports</b> |                  |      |         |                  |
|-----------------------------|------------------|------|---------|------------------|
|                             | Unpaired t-value | DF   | P-value | Pooled Cohen's D |
| <b>Overcontrol</b>          |                  |      |         |                  |
| YOU-C                       | 0.099            | 9.1  | 0.924   | 0.052            |
| OCYC                        | -1.456           | 11.7 | 0.1719  | 0.698            |
| <b>Pleasure/Reward</b>      |                  |      |         |                  |
| TEPS<br>Consummatory        | 0.156            | 16.0 | 0.878   | 0.057            |
| TEPS<br>Anticipatory        | 0.687            | 12.1 | 0.505   | 0.325            |
| <b>Psychiatric Symptoms</b> |                  |      |         |                  |
| EDE-Q Global                | -0.151           | 12.2 | 0.882   | 0.071            |
| EDE-Q Restraint             | -1.175           | 13.7 | 0.260   | 0.531            |
| SCARED                      | -0.825           | 10.4 | 0.428   | 0.412            |
| CDI Total T                 | -1.777           | 10.3 | 0.0105* | 0.994            |
| <b>Wilcoxon W</b>           |                  |      |         |                  |
| SCS                         | 37               | N/a  | 0.525   | 0.249            |
| PQ-LES-Q                    | 75               | N/a  | 0.0213* | 0.835            |
| <b>Neural</b>               |                  |      |         |                  |
|                             | Unpaired t-value | DF   | P-value | Pooled Cohen's D |
| Fz Doors RewP<br>Amplitude  | -1.567           | 15.5 | 0.137   | 0.706            |
| Flanker Cz ERN<br>resid     | -0.116           | 8.06 | 0.910   | 0.064            |
| Flanker Cz Pe<br>Amplitude  | 0.703            | 15.0 | 0.493   | 0.360            |
| Flanker Pz Pe<br>Amplitude  | 0.984            | 15.0 | 0.341   | 0.500            |

*Note:* OCYC = Overcontrol in Youth Checklist–Adolescent; YOU-C = Youth Over- and Under-Control measure; TEPS = Temporal Experiences of Pleasure Scale; Ant = Anticipatory; Cons = Consummatory; EDE-Q = Eating Disorder Examination – Questionnaire; SCARED = Screen for Child Anxiety Related Disorders; CDI T = Child Depression Inventory T-score; PQ-LES-Q = Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; SCS = Social

Connectedness Scale. Fz and Cz = recording from this EEG electrode; Doors = Doors task; RewP = reward processing, loss – win trials; Flanker = Flanker task resid = residual; ERN = error-related negativity; Pe= error positivity.



**Table 4***Change from baseline to post-treatment within the treatment group*

| <b>Symptom Self-Reports</b> |                |     |                             |                         |                  |
|-----------------------------|----------------|-----|-----------------------------|-------------------------|------------------|
|                             | Paired t-value | DF  | P-value (not FDR corrected) | P-value (FDR corrected) | Paired Cohen's D |
| YOU-C                       | 1.767          | 12  | 0.1026                      | 0.137                   | 0.490            |
| OCYC                        | 2.755          | 12  | 0.0174*                     | 0.043*                  | 0.764            |
| TEPS                        | -1.794         | 12  | 0.098                       | 0.137                   | 0.498            |
| Consummatory                |                |     |                             |                         |                  |
| TEPS                        | -1.598         | 12  | 0.136                       | 0.151                   | 0.443            |
| Anticipatory                |                |     |                             |                         |                  |
| SCS                         | 0.897          | 12  | 0.387                       | 0.387                   | 0.249            |
| SCARED                      | 2.909          | 12  | 0.013*                      | 0.043*                  | 0.807            |
| PQ-LES-Q                    | -3.011         | 12  | 0.0108*                     | 0.043*                  | 0.835            |
| Wilcoxon signed rank V      |                |     |                             |                         |                  |
| EDE-Q Global                | 69             | N/a | 0.1099                      | 0.137                   | 0.447            |
| EDE-Q Restraint             | 21             | N/a | 0.0933                      | 0.137                   | 0.436            |
| CDI Total T                 | 82.5           | N/a | 0.0107*                     | 0.043*                  | 0.994            |
| <b>Neural</b>               |                |     |                             |                         |                  |
|                             | Paired t-value | DF  | P-value (not FDR corrected) | P-value (FDR corrected) | Paired Cohen's D |
| Fz Doors RewP Amplitude     | 1.256          | 10  | 0.238                       | 0.795                   | 0.379            |
| Flanker Cz ERN resid        | 0.614          | 9   | 0.554                       | 0.795                   | 0.194            |
| Flanker Cz Pe Amplitude     | 0.267          | 10  | 0.795                       | 0.795                   | 0.081            |
| Flanker Pz Pe Amplitude     | 0.269          | 10  | 0.794                       | 0.795                   | 0.091            |

*Note:* YOU-C = Youth Over- and Under-Control measure; OCYC = Overcontrol in Youth Checklist–Adolescent; TEPS = Temporal Experiences of Pleasure Scale; SCS = Social Connectedness Scale; SCARED = Screen for Child Anxiety Related Disorders; PQ-LES-Q = Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; EDE-Q = Eating Disorder Examination – Questionnaire; CDI Total T = Child Depression Inventory Total T-score. Fz and Cz = recording from this EEG electrode; Doors = Doors task; RewP = reward processing, loss –

win trials; Flanker = Flanker task resid = residual; ERN = error-related negativity; Pe= error positivity.

**Table 5**

*Baseline ERN (Cz Flanker residual) as a predictor of change in outcomes in the treatment group, controlling for age and number of sessions*

| Outcome  | R-squared | Adjusted R-squared | F-statistic | P-value |
|----------|-----------|--------------------|-------------|---------|
| YOU-C    | 0.70      | 0.40               | 2.34        | 0.25    |
| OCYC     | 0.33      | -0.68              | 0.33        | 0.81    |
| PQ-LES-Q | 0.34      | -0.65              | 0.34        | 0.80    |
| SCARED   | 0.83      | 0.59               | 3.38        | 0.24    |
| CDI T    | 0.55      | -0.13              | 0.81        | 0.59    |

*Note:* YOU-C = Youth Over- and Under-Control measure; OCYC = Overcontrol in Youth Checklist–Adolescent; PQ-LES-Q = Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; SCARED = Screen for Child Anxiety Related Disorders; CDI T = Child Depression Inventory T-score.

**Table 6**

*Baseline RewP (Fz Doors) as a predictor of change in outcomes in the treatment group, controlling for age and number of sessions*

| Outcome  | R-squared | Adjusted R-squared | F-statistic | P-value |
|----------|-----------|--------------------|-------------|---------|
| YOU-C    | 0.39      | 0.16               | 1.71        | 0.24    |
| OCYC     | 0.12      | -0.20              | 0.38        | 0.77    |
| PQ-LES-Q | 0.08      | -0.27              | 0.22        | 0.88    |
| SCARED   | 0.30      | 0.04               | 1.15        | 0.39    |
| CDI T    | 0.18      | -0.13              | 0.57        | 0.65    |

*Note:* YOU-C = Youth Over- and Under-Control measure; OCYC = Overcontrol in Youth Checklist–Adolescent; PQ-LES-Q = Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; SCARED = Screen for Child Anxiety Related Disorders; CDI T = Child Depression Inventory T-score.

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