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A critical discussion regarding the effectiveness of Cognitive Behavioral Therapy and Cogmet-Working Memory Training in youth with ADHD: scoping Randomized Clinical Trials

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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a pervasive, neurodevelopmental, and lifelong disorder, whereby inattention, and impulsivity and hyperactivity are the core deficits that are produced by. Social relationships and academic attainment and so, Working Memory components are crucial aspects that also get affected. The adaptation of ADHD in youth environment may lead comorbid disorders to present and therefore, the assessment of such condition should apply in parallel to the expression of symptoms (age of seven). However, difficulties in tackling the condition and high rates of misdiagnosed and missed to diagnosed cases makes the need for effective interventions imperative. Satisfactory therapeutic outcomes have been developed for assisting youth with ADHD. This review analyses two of them; Cognitive Behavioural Therapy and Cogmet-Working Memory Training. These where explored by assessing their efficacy viewing Randomised Clinical Trials published in PubMed.gov and Clinicaltrials.gov databases. In accordance with interventions selective action, CBT examined in its efficacy for tackling comorbid disorders and CWMT on its effectiveness in reinforcing Working Memory. Results have been made for their non-effectiveness in tackling ADHD symptomatology. Discussion for a setting of variables when finally, a young person with ADHD is assessed.

Keywords:

ADHD; Youth; CBT; CWMT

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Introduction

ADHD (attention-deficit/hyperactivity disorder) is a neurodevelopmental disorder affecting between 3% and 5% of the general population and is characterized as a pervasive and lifelong condition [1]. The core traits that are manifested by the condition are inattention, and impulsivity and hyperactivity that form the predominantly inattentive and the hyperactive-impulsive type respectively. The combined-type which captures all three core traits is the most prominent whereas all types impair typical functioning [2; 3]. The condition emerges in early age, especially during elementary school and is neurodevelopmental precisely because it seems to have an onset on early age [4]. However, reconsiderations have been made regarding its onset on later ages [5]. Early diagnosis is crucial at the age of seven whereby symptoms start to be manifested, because treatment must go parallel with the expression of symptoms to avoid the adaptation of ADHD on children's environment which can lead to continuum ADHD and to a wide range of disorders in adult life [6]. The 4% prevalence in adults precisely explains that most of the ADHD youth cases are misdiagnosed or missed to diagnosed [7]. However, when a young person with ADHD is finally under the supervision of specialists, the inability to recognize the person's difficulties and the ineffective action of interventions to the ADHD condition can leave deficit residues, leaving the young person exposed to be shaped by this complex and challenging genetic-mental state [8]. ADHD in youth overlaps with comorbid disorders; anxiety, mood and substance use disorders, ODD (Oppositional Defiant Disorder) and CD (Conduct Disorders) are commonly reported in pediatric [9; 10]. ADHD diagnoses are often accompanied by increased risk for impaired social relationships as well as learning difficulties [11] which are produced by deficits on WM (Working Memory), acknowledging the fact that many of its functions are getting overshadowed by the symptoms of ADHD [12]; 13]. Psychoeducational input, CBT (Cognitive Behavioural Therapy), interpersonal psychotherapy, family therapy, school-based interventions, social skills training, behavioral peer intervention, CWMT (Cogmet-Working Memory Training) and neurofeedback concern the most prevalent interventions against ADHD.

This literature review aims to investigate under a comparative scope the effectiveness of CBT and CWMT. This methodological approach of the most relevant RCT studies published yielded the existence of essential differences in outcomes followed by the utilization of the abovementioned psychological interventions in young people expressing the ADHD condition. Due to the overlapping phenomenon of comorbidity and the plethora of the aspects that are affected, tackling the condition becomes challenging. Thus, the RCT studies examined for this review either have applied one of the two approaches or another one e.g., medication, to investigate the interaction of such interventions with specific symptoms and comorbid disorders. For this purpose, and because of the lack of evidence concerning the effectiveness of the two approaches in youth, 6 dominant RCT's studies (see Appendix 1) have been analysed. Evidence for the advantages and disadvantages of each intervention to serve the tackling of ADHD by minimizing deficits in specific aspects emerged by the analysis and thus, a synthetical discussion will follow.

Methods

For unfolding the condition of ADHD, despite the reconsiderations that have been made regarding its definition, this study used parts of DSM-IV and DSM-V to define it. The analysed RCT studies have been selected from the PubMed.gov and Clinicaltrials.gov databases. The including criteria for selecting articles studies published in the chronic frame of 2010-2020 investigating the efficacy of CBT and CWMT on ADHD young patients, targeting major difficulties faced in ADHD condition. Among the two approaches utilized to confront with ADHD in youth, the selected studies adapted CWMT, a reformed version of CBT for adults with ADHD, pharmacotherapy, placebo, combinations of CBT and pharmacotherapy, Behavioural Parent Training (BPT) and waiting lists. CASP check of the six studies appeared to be satisfying, since the clinical population that was recruited was young

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individuals and therefore, ethical considerations and strict data analysis was fulfilled (Appendix 2).

The lack of research, the small sample sizes, the withdrawal of participants from most trials and the fact that none of the studies can capture the whole condition to tackle difficulties, made the selection of the studies extremely strict. The keywords used in the initial search was "ADHD", "Youth", "CBT", "CWMT" and "Randomised Clinical Trials". Studies published in English were putted on the scope, to minimize time and issues with translating. Six articles have been chosen to be analyzed on the core of the efficacy of the approaches to tackle difficulties emerged by ADHD, accordingly to their selective action. Therefore, CBT approaches utilized in the three studies will be evaluated in their efficacy in tackling anxiety, mood, ODD and CD, whereas the CWMT in the other three studies, specialized to target WM operation and amended to stabilize it by interacting with the verbal and non-verbal WM storage, the visual spatial WM and the WM spans (Appendix 3). CBT and CWMT are cognitive and behavioural intervenor tools.

CBT and CWMT cores

CBT is a psycho-social intervention that aims to improve mental health, whereby it focuses on challenging and changing cognitive distortions and behaviors, improving emotional regulation [14]. According to Sprich et al. [15] CBT is an effective intervention used for minimizing symptoms of ADHD. However, this effectiveness emerges when it comes to adult population and especially when anxiety and mood disorders are coexisting with the condition [16] yet again, CBT remains the most widespread intervention utilized in youth with ADHD. Psychoeducation and organizing/planning, coping with distractibility, adaptive thinking, addressing procrastination and involvement of a partner, or a caregiver when it comes to youth, are components constituting the core of a CBT approach for individuals with ADHD [17]. CWMT is a software program created to assist individuals with ADHD and expanded to other impairments of WM, including learning difficulties [18]. Relying on the brain plasticity theory, CWMT targets to amplify poor WM abilities (executing, organizing, planning, holding attention, storage and manipulating information) and to reduce refusion, disorganizing, retrospection, inattention, and rejection of information, components of ADHD completely opposed to the WM function [19]. According to Chacko et al. [20] CWMT might be very effective for youth with ADHD. However, a metanalysis of WM training techniques (including CWMT) yielded non-durable and near-transfer effects, and limited transference of attention deficits, grounding on the abstract model of WM. CWMT is utilized as an active form which targets verbal and nonverbal working memory components and the visuospatial sketchpad, a WM memory component which process visuospatial stimulus, whereas in low stimulation, it may be utilized as a placebo form [20].

Assessing the efficacy of CBT in youth with ADHD

Narrowing down Safren et al.'s [16] protocol for Adults with ADHD showing unresolved by the medication symptoms program, Antshel et al. [21] and Sprich et al. [22] shaped it to frame the young age. Components such as the motivational interviewing, review, practice and repetition of trained skills, psychoeducation about ADHD, training in organization and planning and distractibility reduction skills, improving communication skills and more specifically reducing interruptive tendencies and improving active listening, reducing procrastination, and improving anger/frustration management by using cognitive restructuring strategies described by Beck [23]. CBT clearly has provided awareness efficacy in child and adolescent populations, whereby CBT is accepted as the most effective in adolescents relative to preadolescents, implying that adolescents have more mature cognitive abilities that may adequate the efficacy of a CBT intervention [24; 21]. However, cognitive development may vary regarding individuals' differences and so, it may not go parallel with the biological age of youth [25]. Therefore, CBT techniques may be considered as weak, acknowledging the fact that they may miss the cognitive age of youth. Halldorsodit et al. [26], regardless the fact that they admitted that ADHD as an entity may pose risks

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in youth's ability to involve in meditative cognitive restructuring during the sessions, and hypothesizing that comorbid anxiety disorders (e.g., Generalized Anxiety Disorder, Separation Anxiety Disorder and Social Anxiety Disorder) may block CBT's reconstructive action [27], they putted on the scope the comorbid phenomenon of ADHD and ODD, for better controlling the retrograded manifestation of the conditions. But this fact rejects other comorbid conditions to be considered as predictors and/or moderators. After 12 weeks of treatment and 6 months follow-up treatment, results were created for the low effectiveness of CBT in serving the need to eliminate or reduce the coexisting anxiety in youth with ADHD. Furthermore, they suggested that a comorbid phenomenon, such as ADHD+ODD should be perceived as a common entity, precisely because when they examined youth with ADHD, independent to ODD, poorer CBT outcomes yielded in contrast to youth confronting only with ADHD.

Antshel et al. [21] made a satisfactory indication and manipulation of the most prevalent to ADHD comorbid disorders (ODD/CD anxiety and mood disorders), whereby levels of ANX and DEP were showed a greater decrease than of the ODD/DD levels. However, regardless of scoping the psychiatric comorbidity, Antshel et al. [21] by utilizing an ANCOVA design also including ADHD subtypes, gender influence and their interactions, did not yield for the efficacy on unblurring or tackling the ADHD subtypes or even to capture gender potentiality. The latest brings to the fore, that even that variables were included in the design as external variables, biological factors that mask the manifestation of ADHD in females, or even indicators of Socio-Economic Status were not captured. Sprich et al. [22] yielded results for the efficacy of CBT for medication treated youth with ADHD who prolonged to unveil persistent symptoms, despite taking medication. Both Antshel et al. [21] and Sprich et al. [22] studies founded specific variables to be improved, including youth self-report of self-esteem, as well as parent and teachers rating of distractibility and inattentive symptoms. Yet, all the participants were founded not to be able to standardize their functionality and persisted in expressing symptoms and difficulties in at least on domain. Halldorsodit et al. [26] produced evidence opposite to Sprich et al. [22] findings. By comparing the effectiveness of CBT opposite to medication and in combination, the latest yielded a significant treatment effect in the posttreatment phase. However, this significance was grounded only in tackling anxiety when isolated, whereas youth with isolated ADHD did not benefit. This fact reveals the inferiority of CBT in reducing symptoms of ADHD in youth. Moreover, the fact that symptoms of anxiety was decreased only when CBT was combined with medication, also exposes that CBT is may be considered as a useful complementary tool to reduce e.g., anxiety within ADHD, and not as a holistic tool that a) will explain the situation and b) will control it. Sprich et al. [22] study, as an initial trial was grounded on a relatively small sample size, a fact which retrogrades the possibility of obtaining statistical power. Antshel et al. (2012) had to deal also with small sample issues. Across all variables, the number of participants was degreased in the post-treatment phase in contrast to the pro-treatment whereas only a 55% of the sample attendance was succeeded during the CBT intervention's modules. Thus, they did not produce supporting evidence for the effectiveness and validity of CBT on a given and necessary sample, bringing to the fore methodological and stastistical flows.

Assessing the efficacy of CWMT in youth with ADHD

Chacko et al. [28] and van Dongen et al. [29] compared CWMT in its active and placebo form and Steeger et al. [30] by adapting a more systemic approach selected Behavioral Parent Training to explore it parallel to CWMT, whereby the experimental procedures in the three studies had 5 weeks of duration. On the family's schedule, utilizing time-on tasks with computer training active and a placebo form of CWMT, Chacko et al. [28] produced a slightly significant greater result yet, statistically unsignificant, in the active phase on teacher-rating ADHD symptoms: objective measures of inattention, hyperactivity and impulsivity, measures of verbal and nonverbal working memory manipulation, and academic achievement. Using a multilevel linear modeling, the opportunity to capture individual differences reflected across

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the duration of the time-on tasks was given. Time as a variable had a significant effect yet, only when aspects of WM and academic achievement were in the scope. Overall, van Dongen et al. [29] by measuring outcomes first for the core behavioral symptoms of ADHD and second at the behavioral, neurocognitive, and global clinical functioning, found a significant improvement in favor of the active CWMT on a verbal task reflecting activations on verbal working memory yet, no significant treatment effect was produced on the whole of first level and the second level of measures. Steeger et al. [30] evident an improvement effect of CWMT in WM spans and the inferiority of the Behavioral Parent Training on minimizing youth's symptoms. Moreover, no combination of interventions treatment effect was found yet, this potentially may be blocked by the effectiveness of the CWMT on improving WM. Therefore, CWMT succeeded to influence in a positive ground two aspects that affected by ADHD, WM and learning attainment, conceptualizing their correlative relationship as a codependent entity [31]. In an opposite direction, Chacko et al. [28] achieved statistical significance in caregivers-rates when combined CWMT and Behavioral Parent Training, whereby when time as a variable was consider, the caregivers-rates reported reduction of youth's behavioral difficulties. However, inattention and impulsivity and hyperactivity, did not receive a significant treatment influence or at least did not get explained when youth's WM was getting amplified. The latest creates space for what van Dongen et al. [29] discussed. Grounded on a very strict and synthetical analysis, they revealed CWMT's ineffectiveness in both primary and secondary outcomes. This fact brings to the fore first, the strict selective action of CWMT and methodological flows which they did not allow for inattention and impulsivity and hyperactivity to be captured and improved.

Maternal rating on both Chacko et al. [28] and Steeger et al. [30] studies produced non-significant results accompanied by small effect sizes regarding the reduction of inattention and hyperactivity symptoms. This fact forces the analysis of the data resulted to narrow down in two explanations for this: the selective action of CWMT on amplifying verbal WM and WM functionality, and more specifically, on improving visuo-spatial sketchpad component, acknowledging its contribution on manipulating and compromising visual and spatial stimulus and the existence of an uncontrollable personal bias which may masked inattentive and hyperactivity issues. The latest bias refers to the fact that mothers of ADHD youth formed unreal expectations for the efficacy of CWMT in terms of its therapeutic action in all the symptoms of the condition or it has been conceptualized as a difficult program, which may also lead to its non-suitable utilization, acknowledging the fact that the task of the experimental approach had a home-based execution. Regarding its difficulty, all three studies pointed the training issues that may emerged during the execution of the procedure which may be produced an overloading to the executive functions of youth with ADHD. Thus, van Dongen et al. [29] suggested that tasks should be designed to force a growth in the general attentional capacity, for tackling inattentional bias and distractions that may emerge by the task, to create a transfer effect of execution to unfamiliar tasks.

Discussion

The aim of the present study was to analyze the potentiality of CBT and CWMT on tackling the challenging difficulties that youth with ADHD face. In addition, given the high percentage of misdiagnosed and missed to diagnosed cases, some satisfactory indications produced regarding a specific setting of variables that may be considered when finally assessing youth with ADHD. CBT, as a behavioural approach, is the most effective psychosocial intervention for tackling the most common challenging disorders, such as mood and especially anxiety disorders in youth [21; 22; 26]. However, regarding ADHD symptomatology, CBT has been found to be particularly beneficial for the adult population with ADHD, whereby the literature on the effectiveness of CBT for youth with ADHD is scarce. CWMT was found to be very effective considering the typical functionality of learning and the operationality of WM, which system works in an opposite direction to the ADHD symptomatology, assisting the ability of achieving and manipulating extraneous loads [28; 29; 30]. However, its effectiveness was limited to restructuring cognitive mechanisms that serve the organizational,

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aggregation, and ability to handle external stimuli without reducing the detached nature of the condition.

Both interventions succeeded to capture aspects that are affected by the ADHD, whereby CBT and CWMT increased calmness and emotional regulation, and WM spans, verbal, and visual WM respectively. Therefore, it arises that both interventions cannot explain and so in capture ADHD condition in a holistic way. Results for their effectiveness in mood, ODD, CD and substance use disorder did not be made since those variables were not putted strictly on the scope, regardless the fact that all six studies utilized an ANCOVA design. Gender differences leading the ADHD spectrum to be masked in females did was be unfolded. This argument emerged from the fact that both boys and girls were included in the same design and tasks. Issues also emerged both by the ability of mothers to evaluate the effectiveness of interventions on their children and the ability of young people to self-evaluate. Another limiting factor, as consensually written in all six studies, is the fact of small samples recruited in such clinical trials.

Acknowledging the data from the above paragraph the scope goes beyond the discussed issues, to unfold and fulfill needs reflected by the analysis of the present study. Overall, CBT and CWMT seem to be more beneficial as supplementary tools rather when used in isolation. Therefore, a combination of the analyzed interventions may lead to a better general reconstruction of individuals by targeting emotional and cognitive dimensions of youth. However, to capture the comorbidity phenomenon, the adaptation of specific-targeted interventions to e.g., ODD and CD, such as the cognitive training skills or parent management, may be considered. A need also exists for the interventions to serve prevention. Thus, their transfer effect may be standardized according to the Cognitive Load Theory [31] which proposes the engagement of a specific brain architecture of individuals when cognitive and emotional reconstruction is the intended goal. Lastly, this study gives a call to the professionals exploring the ADHD condition not to perceive the small number of samples as an issue. Instead off that, they may adapt qualitative approaches in a case-study aspect in order to conceptualize ADHD as unique entity reflected by each youth.

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Appendices

Appendix 1 RCT Studies

Author	Year	CASP	Design	Intervention	Sample (age)	N	Main Findings
Antshel et al.	2012	6/10	Randomised Controlled Trial	Cognitive Behavioural Therapy	8-12	68	Adolescents with ADHD with oppositional defiant disorder were rated by parents and teachers as benefiting less from the CBT intervention. Adolescents with ADHD and comorbid anxiety/depression were rated by parents and teachers as benefiting more from the CBT intervention.
Halldorsodit et al.	2014	9/10	Randomised Controlled Trial	Cognitive Behavioural Therapy	7-17	488	Children in ADHD with comorbid anxiety are less likely to benefit from CBT. ADHD and comorbid ODD should be separately explored.
Sprich et al.	2016	7/10	Randomised Controlled Trial	Cognitive Behavioural Therapy	14-18	49	CBT for youth has an initial efficacy in minimizing persistent symptoms.
Chacko et al.	2013	/10	Randomised Controlled Trial	Cogmet Working Memory Training	7-11	85	CWMT has demonstrated significantly greater improvements in verbal and non-verbal working memory storage.
van Dongen et al.	2015	/10	Randomised Controlled Trial	Cogmet Working Memory Training	8-12	102	Results showed only one replicated treatment effect on visual spatial working memory in favor of CWMT. Effects of time were found for broad neurocognitive measures, supported by parent and teacher ratings. However, no treatment or time effects were found for the measures of academic performance, behaviour in class or quality of life.
Steeger et al.	2016	/10	Randomised Controlled Trial	Cogmet Working Memory Training	11-15	91	CWMT significantly improved WM spans. Combing CWMT with an intervention may lead to the improvement of adolescent WM deficit, behavioural regulation problems, and global executive deficit

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Appendix 2

CASP	Antsel	Halldor-sodit	Sprich	Cha-cko	Van Doon	Stee-ger
1	v	v	v	v	v	v
2	v	v	v	v	v	v
3	v	v	v	v	v	v
4	v	v	x	v	v	v
5	v	v	v	v	v	v
6	x	v	v	v	v	v
7	v	x	x	x	v	x
8	v	x	x	x	x	v
9	x	v	v	x	x	v
10						

CASP

1. Did the study address a clearly focused question or hypothesis?
3. Is the chosen methodology appropriate?
4. Was the research design appropriate?
5. Was the recruitment strategy appropriate?
6. Did data collection strategy fit with the research question?
7. a) If the research is qualitative, has the relationship between researcher & participants been considered?
   b) If the research is quantitative, have relevant methodological issues been outlined?
8. Have ethical issues been considered?
9. Was data analysis sufficiently rigorous?
10. Is there a clear statement of findings?
11. How valuable is the research?

Appendix 3

Authors, year	Interven-tions	Comorbid Disorders	Duration	Instruments	Results
Antshel et al. (2012)	-CBT -Parenting Training -Family therapy -Medication	-Opposition-al Defiant Disorder -Generalized Anxiety Disorder -Major Depressive Disorder -Substance Use Disorder -Learning Difficulties	-Four sessions focused on reducing pro-crastination, improving communica-tion skills -Parents involved in 7 sessions (50min) -CBT for youth 13-16 sessions	-K-SADS-E -BASC-2 -ADHD-RS -GAF -WASI -Parents and teachers IRS	Pretreatment and posttreatment effects were found for several symptom and functional vari-ables. The largest effect sizes were observed for number of weekly missed classes, school tardies, stimulant medication doses, parent-reported ex-ternalizing behaviors, parent-reported inatten-tion symptoms, and teacher-reported inatten-tion symptoms. Across all variables, participants had lower numbers at posttreatment relative to pretreatment.
Halldor-sodit et al. (2014)	-CB -Pharmaco-therapy (i.e., sertraline) -Combi-nation of pharmaco-therapy and CBT, or a pill placebo condition.	-Anxiety Disorders -Opposition-al Defiant Disorder	-6 months (week 12= treatment response, week 32= maintenance of gains)	-ADIS–C/P - Clinical Global Impression Severity Scale - WISC-III	-No differences were found between the comor-bidity groups (i.e., AnxD alone, AnxþADHD, and Anxþ ODD; see Table 2) based on age, IQ, gen-der, ethnicity, severity of anxiety, or targeted AD. -The combination of pharmacotherapy and CBT more likely to respond to treatment at post-treatment than those in the other treatment conditions. -Remission rates were significantly lower in the AnxDþADHD group than the AnxD alone group in the CBT condition.

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Sprich et al. (2016)	-CBT -Waiting List -Waiting List to CBT	No references regarding the comorbidity phenome-non-	-12 sessions (17.31 weeks)	-CGI -K-SADS -Patient Self-report measure of medication adherence	-Adding CBT to medication treatment in youth with ADHD was superior to medications alone.
Chacko et al. (2013)	CWMT Active vs CWMT Placebo	-Oppositional Defiant Disorder -Conduct Disorder-	-2-4 weeks	-Parent and teacher ratings on the Disruptive Behavior Disorder Rating Scales -Impairment Rating Scale -Child Autism Rating Scale -WASI -Nakao and Treas Socioeconomic Prestige Index -AWMA	-Of the 44 participants assigned to CWMT Active, 35 (80%) met compliance criteria (≥20 training days within 5 weeks). Of the 41 participants assigned to CWMT Placebo, 31 (77%) met compliance criteria. Overall, compliance to treatment was high, given that this was a home-based, parent-supported intervention that included a substantial proportion of participants with comorbid ODD.
van Dongen et al. (2015)	CWMT Active vs CWMT Placebo	-Individuals with comorbid disorders were excluded	-25 sessions for 5 weeks	-ADHD-RS -Parents (BRIEF-P) and Teacher (BRIEF-T). -WISC-III -LDT -WPPSI-RN -RAVEN -DNST -SA-DOTS-02K -CGAS	-The results showed a significant improvement in favor of the active condition on a verbal WM task, but this effect did not survive correction for multiple testing. Further, both the active and the placebo condition improved on many outcome measures over time. However, no additional effect in favor of the active condition was found. The task improvement index influenced the BRIEF and ADHD Rating Scale IV outcome, both evaluated by teacher, but correction for this variable did not yield significant group differences.
Steeger et al. (2016)	CWMT vs Behavioural Parenting Training -Active Control placebo	Oppositional Defiant Disorder	-2-5-2 weeks of intervention	-WISC-IV -Mothers and teachers BRIEF. -Mothers ADHD-RS, 5-item Oppositional Defiant Problems scale CBCL, 22-item Dyadic Behavior of CBQ -12 items IMI -Behavior Regulation Index -Global Executive Composite -Alabama Parenting Questionnaire	-No evidence that CWMT, either singly, or in combination with BPT, positively affected diverse domains of functioning.