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### To prompt or to praise?

Hornstra, Rianne

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#### **Chapter 4.**

Which techniques work in behavioral parent training for children with ADHD? Evidence from a randomized controlled microtrial

Hornstra, R.

Van der Oord, S.

Staff, A. I.

Hoekstra, P. J.

Oosterlaan, J.

Van der Veen-Mulders, L.

Luman, M.

Van den Hoofdakker, B. J.

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## Abstract

Behavioral parent training (BPT) is an evidence-based intervention for children with attention-deficit/hyperactivity disorder (ADHD), but little is known about the effects of separate techniques parents learn in BPT. In a three-armed randomized controlled microtrial including parents of 92 children (4-12 years) with ADHD, we examined the efficacy of two sessions parent training involving either stimulus control techniques (antecedent-based condition (AC)) or contingency management techniques (consequent-based condition (CC)), compared to a waitlist. Primary outcome were daily parent-rated problem behaviors, secondary outcomes were parent-rated symptoms of ADHD and oppositional defiant disorder (ODD), and mental healthcare consumption. Measures were completed at baseline (T0), immediately after the training (T1), at two weeks (T2) and three months (T3) follow-up. We also explored whether child and parent characteristics moderated treatment effects. Compared to the waitlist, in the AC, daily rated problem behaviors improved at T1 ( $d=.59$ ) and T2 ( $d=.66$ ); in the CC, these behaviors only improved at T2 ( $d=.54$ ). Daily rated problem behaviors within both conditions remained stable between T2 and T3. In the AC compared to the other conditions, inattention symptoms decreased at T1 and T2. For both active conditions compared to waitlist, hyperactivity-impulsivity symptoms decreased only at T2 and ODD symptoms did not decrease. No moderators were identified. Mental health care consumption after training was low and did not differ between the active conditions. Brief training of parents in antecedent- or consequent-based techniques improves problem behaviors of children with ADHD. Antecedent-based techniques appear to be especially important to target inattention.

## Introduction

The effectiveness of behavioral parent training (BPT) as a treatment for children with attention-deficit/hyperactivity disorder (ADHD) has been demonstrated in numerous studies (Evans et al., 2018; Schatz et al., 2020). In BPT programs, clinicians teach parents to use different behavioral techniques aimed at increasing desirable behaviors and preventing or diminishing undesirable behaviors of their child (Antshel & Barkley, 2008). Originally developed for children with generic behavioral problems, most programs are based on learning theory and include principles of operant conditioning (Shaffer, Kotchick, Dorsey, & Forehand, 2001). The types of behavioral techniques that are taught to parents vary between different programs (Leijten et al., 2019; Hornstra et al., 2022). So far, studies into BPT for children with ADHD have investigated the effectiveness of programs as a whole, whilst studies about the efficacy of the specific behavioral techniques that comprise BPT are scarce (Daley et al., 2017). Knowledge about which specific components of BPT contribute to the efficacy and for whom (which child or parent), is needed to personalize programs, and may eventually be used to enhance the effectiveness of existing programs or to condense these by removing non-effective components (Collins, Murphy, Nair, & Strecher, 2005; Van der Oord & Tripp, 2020).

Psycho-education and advice on behavioral management has been recommended by clinical practice guidelines as the first line of treatment for children with ADHD (NICE guidelines and Dutch guidelines; National Institute for Health and Care Excellence [NICE], 2018; Akwa GGZ, 2019). In most BPT programs, the main goal is teaching parents how to use stimulus control and contingency management techniques (Fabiano, Schatz, Aloe, Chacko, & Chronis-Tuscano, 2015; Hornstra et al., 2022). Stimulus control techniques are used to manipulate or restructure the events or tasks that precede behavior (i.e., antecedent-based techniques) and are aimed at eliciting desired behavior and preventing undesired behavior. For example, at dinner time, clear expectations about the behavior of the child and removing distractions such as toys make it easier for the child to stay seated during dinner. Contingency management techniques are used to manipulate the consequences of behavior (i.e., consequent-based techniques), with the aim to promote desired behavior and to diminish undesired behavior. For instance, compliments for staying seated at dinner time (positive reinforcement), and ignoring wobbling on the chair will facilitate the child to stay seated (Antshel & Barkley, 2008). In most BPT programs both types

of techniques are combined, e.g., providing clear instructions to elicit desired behavior and rewarding desired behaviors. Programs that have been studied are typically quite long (8-12 sessions; Evans et al., 2018). To our knowledge, research into brief BPT (less than three sessions) for children with ADHD is lacking. For children with generic behavioral problems, some brief programs are available but these are aimed at prevention and mostly used in primary care settings (Smith et al., 2020).

The effectiveness of the different techniques that are being used in BPT has not been studied so far in samples of children with ADHD. Studies with broader samples of children with disruptive behaviors point towards differences in the effectiveness between specific behavioral techniques. For example, a meta-analysis on parent training programs for disruptive child behavior that include different techniques showed that programs including consequent-based techniques, such as positive reinforcement, praise, and providing natural/logical consequences were associated with larger effects than programs without these techniques (Leijten et al., 2019). However, with the meta-analysis methodology that has been used in that study, effects of other components or techniques that were also part of the interventions could not be ruled out, as techniques were not investigated in isolation. Another meta-analysis that specifically explored effectiveness of experimental studies that manipulated distinct parenting behaviors (praise, verbal reprimands, time-out, and ignoring) to improve child compliance (including typically developing children, children at-risk or referred for non-compliant behavior) showed that all techniques, except praise, were effective in increasing children's compliance (Leijten, Gardner, Melendez-Torres, Knerr, & Overbeek, 2018). However, in that meta-analysis, studies on interventions using antecedent-based techniques were not included. Some observational studies into effects of specific antecedent-based techniques for children with persistent noncompliant behavior have been conducted, and found the appropriate use of verbal instructions (direct, short and clear) and verbally assisting a child during a task of importance for reducing child non-compliance (Kalb & Loeber, 2003). Studies in which separate components of BPT were directly compared to each other are limited. Two experimental studies showed that labeled praise (i.e., explicitly referring to the behavior for which the child receives praise, e.g., 'well done brushing your teeth!') was not superior to unlabeled praise (e.g., 'well done!') on compliance of children with disruptive behavior (Leijten et al., 2016). A recent study conducted by our research group into the efficacy of antecedent-based and consequent-based

techniques in behavioral training for teachers of children with ADHD, found that both types of techniques were effective in improving problem behavior (Staff et al., 2020).

Randomized controlled microtrials are an excellent way to examine the efficacy of different techniques of interventions (Howe, Beach, & Brody, 2010; Leijten et al., 2015; Howe & Ridenour, 2019; Staff et al., 2020). In a microtrial, the effect of manipulations of the environment (i.e., a component of an intervention) is examined on a proximal, specific outcome. The results of microtrials are informative to examine whether, how, and to which extent, certain components need to be used in full training programs, and can be used to adapt programs to enhance their effectiveness. Also, microtrials can be useful to determine the effects of separate components in different subgroups. Because of the experimental nature and immediate measurement of outcomes after manipulation, and the fact that only one component of an intervention is manipulated, microtrials are powerful in detecting moderation effects (Howe & Ridenour, 2019). Whereas in regular randomized controlled trials of complete BPT programs effects on ADHD symptoms or behavioral problems are usually measured with questionnaires (i.e., a more distal outcome), in microtrials specific proximal outcomes such as meaningful change of clearly defined target behaviors is the primary outcome measure. Ecological momentary assessment (EMA) methods, such as daily rated problem behaviors, may be particularly suitable for this purpose. These methods have the advantage of reducing recall bias and improving ecological validity (Russell & Gajos, 2020).

The goal of the present study was to test the efficacy of two different sets of techniques that are commonly used in BPT programs, i.e., antecedent-based techniques, and consequent-based techniques, as compared to a waitlist control group and to each other. For this purpose, we developed two short training programs for parents of children with ADHD; one in which parents were taught antecedent-based techniques, and one in which parents were trained in consequent-based techniques. Our primary outcome was daily rated problem behavior of the child, measured by telephone calls in which parents were asked to rate the individualized behaviors of their child on that particular day. As secondary outcomes, we also examined parent-rated ADHD and ODD symptoms using questionnaires, and explored the effects on the consumption of mental health care three months after the training. Research suggests that children who received low intensity BPT prior to medication, demonstrate larger

behavioral improvements, resulting in less medication use overall, than children initiating treatment with medication (Coles et al., 2019; Pelham et al., 2017). To generate hypotheses about possible subgroups for whom specific BPT techniques are better suited, we explored whether characteristics of the child and parent that are commonly identified in clinical practice (i.e., age, IQ, sex, parental education level, baseline levels of ADHD, ODD, and CD symptoms, and impairment) moderated the effects of the techniques.

## **Method**

### **Participants and procedure**

Participants were parents of children from six different outpatient mental health clinics throughout the Netherlands, in both rural and urban areas. Inclusion criteria for the children were (a) being 4-12 years old; (b) having a Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) based diagnosis of ADHD (confirmed with the Diagnostic Interview Schedule for Children-IV, parent interview, DISC-IV; (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000)), which we adapted to the DSM-5; (c) that their parents rated at least four problem behaviors (including inattentive, hyperactive and impulsive symptoms, and oppositional defiant behaviors) as a three or higher on a five-point Likert scale, ranging from 1 ('not severe') to 5 ('extremely severe'), also see *Primary outcome measure*; (d) having an IQ > 70 (if there was no IQ-score listed in the patient file, IQ was estimated using a two-subtest short form of the Wechsler Intelligence Scale for Children (WISC-III-NL) or the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III-NL), including the subtests 'Vocabulary' and 'Block design'; Sattler, 2008), and (e) that they were not using psychotropic medication. If the child had used psychotropic medication in the past, they had to be off medication for at least 4 weeks prior to inclusion. Exclusion criteria for the children were (a) a diagnosis of autism spectrum disorder (as reported by the parent or derived from the patient file) or conduct disorder according to the DSM-5 (derived from the adapted DISC-IV (Shaffer et al., 2000) or the patient file), (b) that their caregivers received BPT in the past year, and (c) the child was not living in one household during the weekdays (as our primary measure had to be reported by the same informant). Parents of children who were deemed eligible were given an

information letter by the clinician, explaining the research aims. When parents expressed interest in the study, they received a telephone call from the research team, explaining the study and procedures in more detail. After parents signed informed consent, parents and children were screened for eligibility. Parents were recruited from May 2017 to September 2019 and received a small compensation (€10) for participating in the study. Medical ethical approval of this study was waived by the Medical Ethical Committee of the University Medical Center Groningen (UMCG; METc 2016/197). The study was registered at the Dutch Trial Register: <https://www.trialregister.nl/trial/6011>, and a more detailed study protocol can be found on <https://osf.io/pbkj6/>. Because there are no clear guidelines for reporting microtrials, we used as the closest proximate the CONSORT-SPI 2018 extension (Montgomery et al., 2018) for reporting on randomized controlled trials of social and psychological interventions.

### **Design and assessment schedule**

We conducted a randomized controlled microtrial with two active conditions (i.e., antecedent-based condition (AC), and consequent-based condition (CC), see *Treatments*) and a waitlist control condition. Baseline assessments were conducted before the randomization and start of the active or control condition (T0). Participants were randomly assigned (block randomization) by an independent research assistant to one of the three study conditions (i.e., AC, CC, or the control condition) in a ratio of 1:1:1, using an online random number generator. The first post-assessment was conducted one week after the training or waiting period (T1), the second post-assessment was conducted three weeks after the training or waiting period (T2). After T2, all parents were allowed to receive care as usual. For the two active conditions only, a follow-up assessment (T3) was conducted three months after T2. Our primary outcome was administered through short telephone calls, our secondary outcomes through online questionnaires and an interview. All outcomes were completed by primary caregivers (i.e., the caregiver who spent the most time with the child).

### **Treatments**

The parent training sessions of both active conditions were based on evidence-based parent training programs (Van den Hoofdakker et al., 2007; Barkley, 1997; Forehand & McMahon, 1981), all aimed at



behavior change, and developed together with the teacher training sessions of our microtrial into behavioral teacher training (Staff et al., 2020). The rationale, session plans, examples, frequently asked questions, and specific ways to avoid contamination were documented in a manual for the therapists. Both conditions were delivered in an individual format at the clinic, consisting of two sessions of two hours each, and were provided in two consecutive weeks, if possible. In case of missed appointments, the sessions were rescheduled, with a maximum of four weeks between session one and session two. Both parents/caregivers were encouraged to participate in the training. Prior to T0, parents selected four behaviors from an extensive list of different problem behaviors that they wanted to target during the sessions (see *Primary outcome measure*; daily rated problem behaviors), and indicated in which situations the behaviors occurred most prominently.

The first training session started with psycho-education about ADHD and possible underlying mechanisms. In the AC, parents were provided with information about executive functioning deficits in children with ADHD. It was explained that children with poorly developed executive functions may fail to adapt their behavior to situational demands, thus prompting the need for antecedent-based techniques (Van der Oord & Tripp, 2020). Parents learned how stimuli in situations can evoke behavior and how and which antecedent-based techniques can be used to manipulate those stimuli, in order to elicit appropriate behavior and prevent unwanted behaviors (Stocco & Thompson, 2015). For example, by setting clear rules and making these visual with pictograms. In the CC, parents learned how consequences can affect behavior, and how and which consequent-based techniques can be used to change behaviors (Van der Oord & Tripp, 2020), e.g., by ignoring unwanted behaviors of the child, and praising every attempt to show the appropriate behavior. They were also provided with information about altered reward sensitivity in children with ADHD and how consequent-based techniques can be used to support this (Stocco & Thompson, 2015). After that, in both the AC and the CC, one of the four problem behaviors was selected to be addressed in that session, based on frequency, severity, changeability, and burden to parents of that problem behavior. The therapist and the parents made a detailed behavioral analysis of the selected behavior and formulated a desired target behavior. The therapist used functional analysis (Virués-Ortega & Haynes, 2005) of the behavior to decide which techniques (depending on the condition) had to be part of the individually tailored intervention plan,

which was designed together with the parents. At the end of the session, parents practiced the techniques through guided role-play or visualization and after that potential barriers towards implementation of the plan were discussed. In the AC, the intervention plan consisted of antecedent-based techniques only (i.e., defining rules, giving clear instructions, anticipating misbehaviors, and providing structure in time and space). In the CC, the intervention plan consisted of only consequent-based techniques (i.e., planned ignoring, praise, rewards, and punishment). Within a condition, specific techniques of that condition could be given in isolation or combined, although therapists were stimulated to combine the techniques of that specific condition to maximize their impact (e.g., in the AC, the combination of giving clear instructions and providing structure in time and space).

Although artificial, for the purpose of this microtrial, parents were not instructed to praise their child after desired behavior occurred in the AC (but we also did not actively discourage this behavior). In the CC, parents did not learn to provide antecedent-based techniques to elicit the desired behavior. When parents brought up the use of techniques belonging to the other condition, therapists were instructed to say: ‘Perhaps we can try this later. For now, it is important to try out whether the specific techniques we discussed today work for your child.’ Parents had to implement the detailed plan for that target behavior immediately after the session. The second session started with an evaluation of this plan, and, if necessary, adaptations were made. Next, a second problem behavior in a specific situation was selected and the same steps as in the first session were followed.

### **Treatment delivery and fidelity**

Treatments were delivered by nine psychologists, all employed at one of the six different mental health clinics (i.e., not hired or otherwise reimbursed by research funds). They all had comprehensive experience with ADHD and parent training and completed extensive postgraduate training in behavior therapy. Before the start of the study, the therapists received an extensive half-day training in the intervention. Each therapist provided both interventions, to prevent unintended therapist effects. Patient allocation was as much as possible evenly distributed, and also depended on the availability of the therapist and the parents. During the study, the therapists received monthly supervision from two of the authors (SvdO or BvdH, two experienced and licensed cognitive behavioral therapists), and if there were

any concerns or questions of therapists between these meetings, therapists could receive immediate feedback per e-mail, telephone, or in person. All sessions were audiotaped, and after every session therapists filled in a session-form, checking whether they had completed all components of the session. All first sessions (AC and CC) from every therapist were listened back immediately by SvdO and BvdH, to check therapeutic skills and the quality of the sessions, and to provide feedback.

Treatment fidelity was assessed by scoring contamination and percentage addressed session items. Two psychologists with postgraduate training in behavioral therapy and ADHD (AS and RH) checked a randomly selected sample of tapes on contamination. These tapes included all first sessions (both AC and CC) from every therapist (18 sessions). From the remaining sessions, 20% was randomly selected and scored (18 sessions). This resulted in an average of four checked sessions per therapist. Scoring of contamination was based on the procedures of Abikoff (2013, 2015) and was defined as (a) features that were addressed in one condition although these belonged to the other condition, (b) questions or remarks from the therapist that could result in the participants to think of techniques belonging to the other condition, or (c) no adequate reaction from the therapist on remarks or questions from the participants that had to do with techniques from the other condition (i.e., the therapist supporting or elaborating on the suggestion of the parent to use techniques specific to the other condition). We classified contamination as a frequency count of contamination occurrences with: 0 = no contamination, 1 = low contamination, 2 = medium contamination, and >2 = high contamination. Interrater reliability for the scored audiotapes in this study was high, based on a single-rating, absolute-agreement, 2-way mixed-effects model (ICC=.96). Percentage addressed session items in each session was checked in two ways; through the session-forms from the therapists, and through scoring the selected audiotapes.

### **Primary outcome measure**

#### *Daily rated problem behaviors*

Parents selected four behaviors they wanted to be addressed in the training, which were derived from a list of 29 possible problem behaviors including inattentive, hyperactive, and impulsive symptoms, and

oppositional defiant behaviors (see van den Hoofdakker et al., 2007). Parents also had to specify when these behaviors took place, using the Home Situation Questionnaire (Breen & Altepeter, 1991). Examples of problem behaviors in specific situations are ‘walk away during mealtime’, or ‘dawdling while getting dressed’. In short telephone calls (approximately 1 minute), parents were asked, in a neutral way, if these behaviors had occurred that day. For the items scored as yes, parents rated the severity on a Likert scale ranging from 1 (‘not severe’) to 5 (‘extremely severe’). Assessors were instructed not to provide additional information or support during these phone calls. The weekly mean-levels of the behaviors were derived on the basis of the daily ratings of the four selected behaviors over five weekdays, not during holidays (with a minimum of four days). The assessors of the phone calls (RH and research-assistants) were not involved as therapists in the study. The weekly mean-level score was calculated for the five days on T0, T1, T2, and T3. Reliability of this list of 29 possible problem behaviors in the current sample was excellent ( $\alpha = .91$ ). The daily rated problem behaviors can be considered an ecological momentary assessment (EMA) (Shiffman, Stone, & Hufford, 2008). The validity of EMA to measure behavior of individuals with ADHD has been demonstrated in several studies (Migueluez-Fernandez et al., 2018). EMA involves repeated sampling of ongoing behaviors in real time in the natural environment of subjects, therefore increasing ecological validity and reducing recall bias (Russell & Gajos, 2020).

## **Secondary outcome measures**

### *Symptoms of inattention and hyperactivity-impulsivity*

The Strengths and Weaknesses of ADHD symptoms and Normal behavior rating scale (SWAN; Swanson et al., 2012) was used to assess inattention and hyperactive-impulsive behaviors of the child at T0, T1, and T2. The SWAN consists of 18 items which had to be rated by parents on a seven-point scale, from ‘far below average’ to ‘far above average’. The SWAN was reverse coded, to be consistent with other measures used in this study. A lower score reflected less problems, and a higher score more problems. The SWAN has been extensively used in Dutch samples (e.g., Polderman et al., 2007). The

internal consistency of the SWAN in this sample was good ( $\alpha = .84$ ), and convergent and discriminant validity are well established (Swanson et al., 2012).

#### *Symptoms of oppositional defiant disorder*

To identify symptoms of oppositional defiant disorder (ODD), we used the ODD subscale of the Dutch version of the Disruptive Behavior Disorder Rating Scale (DBDRS; Pelham et al., 1992; Oosterlaan et al., 2008) at T0, T1, and T2. The DBDRS assesses symptoms of disruptive behavior disorders. Responses included ‘not at all’, ‘just a little’, ‘pretty much’, and ‘very much’ (score range: 0–3). Higher scores indicate more ODD behavior. The subscale ODD has good construct validity and internal consistency ( $\alpha = .88$ ; Oosterlaan et al., 2008).

#### **Consumption of health care**

Consumption of health care at T3 in the active treatment conditions was assessed in two ways. First, through an interview in which parents were asked whether they had received parent training, counseling, or support after T2 (number of sessions) or whether their child started with medication (yes/no) or received any training or therapy after T2 (number of sessions), and, if yes, to describe the care they had received. Second, this information was cross checked with the patient files, and the information from the interview with the parents was complemented with the additional information of the patient files.

#### **Potential moderators**

Several characteristics of the children were tested as potential moderators of the techniques on our primary outcome measure. We examined age, sex, mean parental education level (all through a demographic questionnaire), estimated IQ, daily rated problem behaviors at baseline (i.e., mean of the four to five selected behaviors, see primary outcome), baseline ADHD, ODD, and CD symptoms, as assessed with the adapted DISC-IV (Shaffer et al., 2000; see for details the Participants and procedures section), and impairment as assessed with the Impairment Rating Scale (IRS; Fabiano, 2006). The IRS measures impairment on seven domains, including relationships with peers, siblings, and parents, family functioning, academic progress, self-esteem, and overall impairment. The scale has been demonstrated

to validly identify impairment in children with ADHD (Fabiano, 2006). We used an adapted version of the scale (in line with the Dutch rating system for academic grading), in which parents rated how impaired they think their child is in each domain on a scale from 0 ('no problem') to 10 ('extreme problem').

### **Sample size**

Estimated mean scores and standard deviations for a priori sample size calculation of power were not readily available for this type of trial. Therefore, we based our sample size on two studies. First, we previously examined the effectiveness of a 12 session BPT program on individual selected problem behaviors of children with ADHD by telephone calls on 10 consecutive days (Van den Hoofdakker et al., 2007). We found an effect-size (pre-post) on these selected behaviors of  $d=.93$ . However, our current interventions consisted of only two sessions, and not a full BPT. Therefore, we expected a smaller effect size than found in that study. Second, Leijten et al. (2016) examined the effects of labeled and unlabeled praise in a microtrial in a sample of children with disruptive behavior disorders. Parents were trained, in one session, to provide labeled or unlabeled praise to their child. Effect sizes on child compliance were moderate (.52 and .68). Combining these two studies, we estimated a medium effect size of .60 for our active conditions compared to the control condition for our primary outcome. For a power of 80%, with an  $\alpha=.05$ , we would need 30 children per group. This resulted in an estimation of a total sample of approximately 90 children.

### **Statistical analysis**

Participants were analyzed on an intention-to-treat basis. Differences between the three conditions in demographic and baseline characteristics were analyzed with ANOVA's (continuous variables) and chi squared tests (categorical variables), using the Statistical Package for the Social Science (SPSS, version 26). To compare the three conditions on our primary and secondary outcomes we conducted multilevel analysis (mixed modeling) using Stata, version 16 (StataCorp, 2019), which takes missing data into account (Twisk, De Boer, De Vente, & Heymans, 2013). Three hierarchical levels were distinguished: outcomes (level 1) nested within subjects (level 2), nested in therapists (level 3). We included a random

intercept at therapist level only if the Likelihood Ratio Test showed a significant improvement of the model fit. Condition (AC, CC, control) was inserted as between subjects factor and time (T1, T2) as within subjects variable. To control for baseline differences, T0 scores were inserted as fixed factor. We analyzed main effects of condition to compare the active conditions to the control condition, and to each other, from T0 to T1 and from T0 to T2. Effect sizes (Cohen's *d*) of both active conditions were computed by dividing the regression coefficient by the (pooled) standard deviation. We considered .20, .50, and .80 as threshold for respectively a small, medium, and large effect (Cohen, 2013). Additionally we examined how many children improved more than half a standard deviation on our primary outcome, and considered this a clinically significant change from T0 to T2 (following the approach of Wise, 2004). We analyzed whether this proportion differed between groups with chi-squared tests. Effects up to three months later within each active condition were assessed by comparing daily rated problem behaviors at T2 to those at T3. We conducted sensitivity analyses to examine whether intervention effects differed between type of daily rated problem behaviors (i.e., inattentive, hyperactive-impulsive or oppositional defiant behaviors). We explored whether a variable significantly moderated the effect of the primary outcome when comparing the active conditions (i.e., AC vs. CC) with each other. Moderator effects were tested by conducting multilevel analyses examining interactions between the condition effect and the candidate moderator variable. For each potential moderator variable, the condition by variable interaction was added to the model to assess whether the change over time (averaged over T1 and T2) differed between levels of the potential moderator. Since moderator analyses were aimed at generating hypotheses about what works for whom, correction for multiple comparisons was not applied. Treatment fidelity was analyzed with independent *t*-tests on percentages of addressed session items and contamination scores between both active conditions. Mental health care consumption at T3 was analyzed using chi-squared or Fisher's exact tests to compare the AC to the CC on psychopharmacological treatment and non-pharmacological mental health care for the parents and child.

## **Results**

### **Sample and allocation**

A total of 92 participants were randomized (see Figure 1). Outcomes were completed by the primary caregivers; 87 mothers, 4 fathers, and one stepmother. An overview of the baseline demographic and clinical characteristics can be found in Table 1. There were no significant differences on any of the baseline variables between the three groups.

### **Treatment fidelity**

Therapist-reported fidelity (based on the checklists filled out after each session) showed an average of 96.7% ( $SD=2.3$ ,  $N=28$ ) of the features covered in the AC and 95.9% ( $SD=1.26$ ,  $N=29$ ) of the features covered in the CC. Fidelity did not differ between the two conditions ( $t(55)=1.62$ ,  $p=.110$ ). Based on scoring of the audiotapes, treatment fidelity was high in both conditions (AC=96.5%; CC=95.5%). In most of the sessions there was no contamination (75.0%), or low contamination (16.7% of the sessions). In two sessions in the AC (5.6%) and one session in the CC (2.8%), medium contamination occurred.

### **Intervention effects**

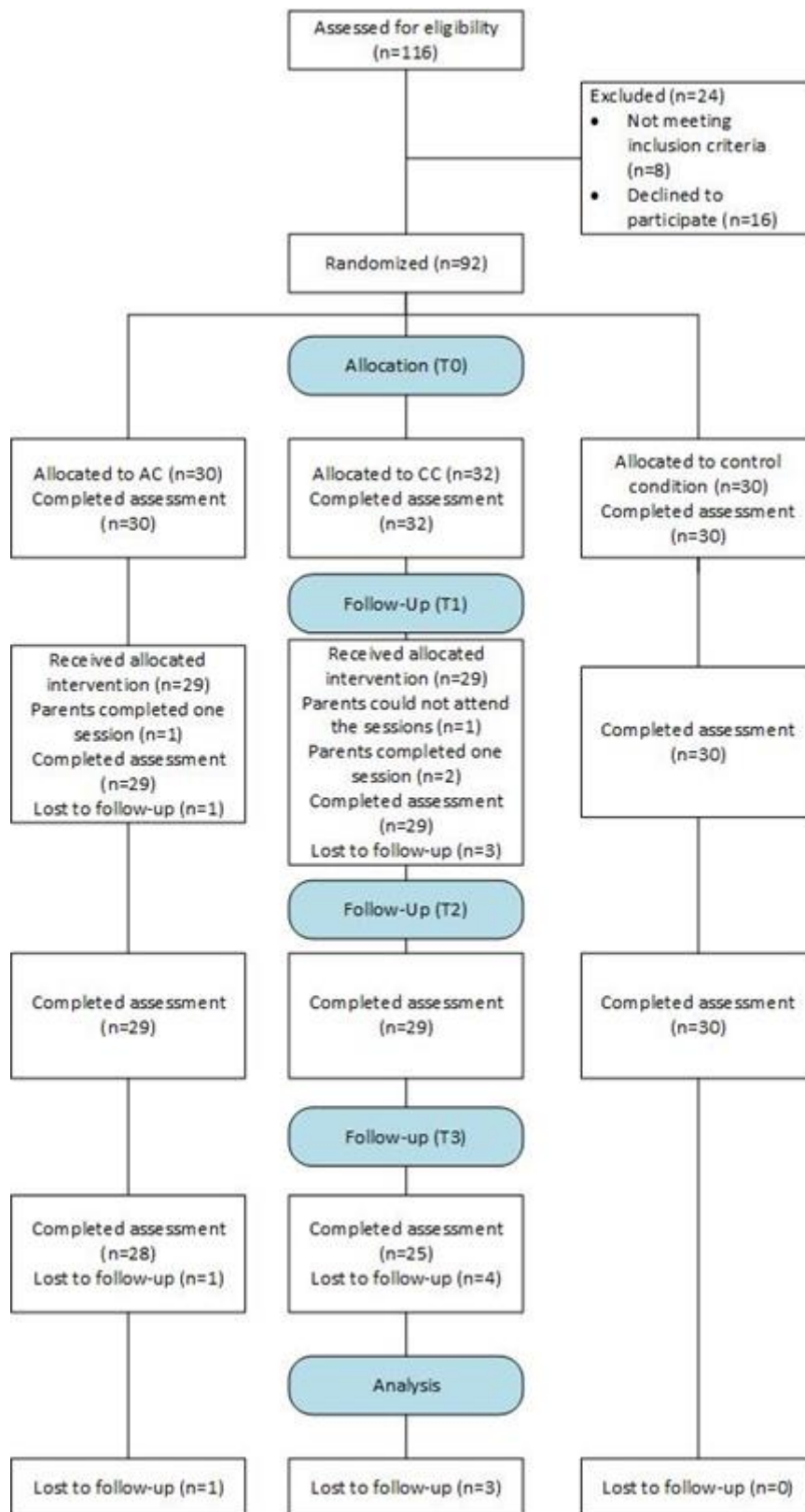
Table 2 presents the effects on the primary and secondary outcome measures of the active conditions compared to the control condition and to each other, from baseline to T1, and from baseline to T2 (means and standard deviations at different time points can be found in Appendix V, Table S1). For all outcomes, the random intercepts at the level ‘therapist’ did not significantly improve the models, so therefore all models were reduced to two levels (observations clustered in children).

### **Primary outcome: Daily rated problem behaviors**

Results of the daily rated problem behaviors are shown in Table 2 and Figure 2. There was a significant decrease in mean scores of daily rated problem behaviors in the AC as compared to the control condition from T0 to T1 and from T0 to T2. Regarding the effect of the CC compared to the control condition, the decrease in mean scores of daily rated problem behavior from T0 to T2 was significant, but not from T0 to T1. The effects of the two active conditions did not differ from each other for both time comparisons. Our analysis on proportions of clinically significant change showed the same pattern (Appendix V, Table B). Within condition analyses of both active conditions revealed that behaviors decreased



significantly from T0 to T1 (AC:  $B=-.63$ ,  $SE=.17$ ,  $p<.001$ , CC:  $B=-.31$ ,  $SE=.17$ ,  $p<.05$ ) and remained stable from T1 to T2 (AC:  $B=-.13$ ,  $SE=.14$ ,  $p=.353$ , CC:  $B=-.24$ ,  $SE=.15$ ,  $p=.124$ ). In the control condition, behaviors did not differ between T0 and T1 ( $B=-.05$ ,  $SE=.11$ ,  $p=.633$ ) nor between T1 and T2 ( $B=-.03$ ,  $SE=.11$ ,  $p=.775$ ). Mean scores of daily rated problem behaviors within both active conditions remained stable between T2 and T3 (AC:  $B=-.05$ ,  $SE=.12$ ,  $p=.704$ , CC:  $B=-.10$ ,  $SE=.12$ ,  $p=.422$ ) and did not differ from each other at T3 ( $B=-.15$ ,  $SE=.18$ ,  $p=.395$ ).



**Figure 1.** Consolidated Standards of Reporting Trials (CONSORT) flow diagram of participants during enrollment, allocation, and follow-up. AC = Antecedent-based condition; CC = Consequent-based Condition.

**Table 1.** Baseline demographic and clinical characteristics for each training condition

	AC (n=30)	CC (n=32)	Control condition (n = 30)	Group comparisons	<i>p</i>
<i>Demographics</i>					
Age in years, <i>M (SD)</i>	7.70 (1.82)	8.39 (1.77)	7.73 (1.76)	$F(2,90)=1.54$	.220
IQ, <i>M (SD)</i>	93.6 (12.8)	99.1 (14.1)	92.9 (11.5)	$F(2, 90)=2.22$	.114
Sex, <i>n (%)</i> boys	20 (66.7)	23 (69.7)	21 (70)	$\chi^2=0.10$	.953
Caucasian, <i>n (%)</i>	29 (96.7)	32 (100)	28 (93.3)	$\chi^2=2.26$	.324
Parental education level, <i>n (%)</i> <sup>a</sup>					
Low	3 (10.7)	9 (29)	8 (28.6)	$\chi^2=3.52$	.172
Medium	11 (39.3)	10 (32.3)	9 (32.1)	$\chi^2=.42$	.810
High	14 (50)	12 (38.7)	11 (39.3)	$\chi^2=.95$	.623
Other psychiatric diagnosis, <i>n (%)</i>					
ODD <sup>c</sup>	15 (50)	11 (34.4)	13 (43.3)	$\chi^2 = 1.83$	.401
Learning disorder <sup>b</sup>	1 (3.3)	2 (6.3)	1 (3.3)	$\chi^2 = .39$	.825
Anxiety disorder <sup>b</sup>	0 (0)	1 (3.1)	0 (0)	$\chi^2 = 1.84$	.399
ADHD presentation, <i>n (%)</i> <sup>c</sup>					
Combined	19 (63.3)	18 (56.2)	21 (70)	$\chi^2 = 1.62$	.446
Predominantly inattentive	7 (23.3)	12 (37.5)	5 (16.7)	$\chi^2 = 3.66$	.160
Predominantly hyperactive-impulsive	4 (13.3)	3 (10)	4 (13.3)	$\chi^2 = .31$	.856
Number of symptoms, <i>M (SD)</i> <sup>c</sup>					
Inattention symptoms	6.90 (1.49)	7.34 (1.75)	7.07 (1.70)	$F(2,89)=.57$	.567
Hyperactivity-impulsivity symptoms	6.83 (1.50)	6.13 (2.89)	6.63 (1.99)	$F(2, 89)=.76$	.469
ODD symptoms	3.54 (2.33)	3.52 (2.83)	2.93 (2.38)	$F(2, 86)=.55$	.582
CD symptoms	.68 (1.22)	.90 (2.10)	.37 (0.93)	$F(2, 86)=.96$	.387
Impairment, <i>M (SD)</i> <sup>d</sup>					
Number of impaired domains	3.75 (1.43)	3.55 (1.40)	3.67 (1.60)	$F(2,85) = .13$	.880
Average score	6.93 (1.84)	6.78 (1.50)	6.62 (1.91)	$F(2,85) = .22$	.801
Mean score of daily rated problem behaviors, <i>M (SD)</i>	2.41 (.85)	2.17 (.81)	2.37 (.89)	$F(2, 89)=.73$	.484

AC = antecedent-based condition; CC = consequent-based condition; ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder; CD = conduct disorder.

<sup>a</sup> Parental education level (average of both parents) was classified according to the Dutch classification system (CBS, 2006). (1 = no education completed, 2 = early childhood education, 3 = primary education, 4 = lower secondary education, 5 = upper secondary education, 6 = undergraduate school, 7 = graduate school, 8 = post-graduate education), divided in low=1,2,3,4, medium=5, and high=6,7,8.

<sup>b</sup> Derived from the patient file.

<sup>c</sup> Assessed with the Diagnostic Interview Schedule for Children-IV-TR, adapted to the DSM-5.

<sup>d</sup> Assessed with the Impairment Rating Scale; domains with a score >3 were classified as impaired.

## Sensitivity analyses

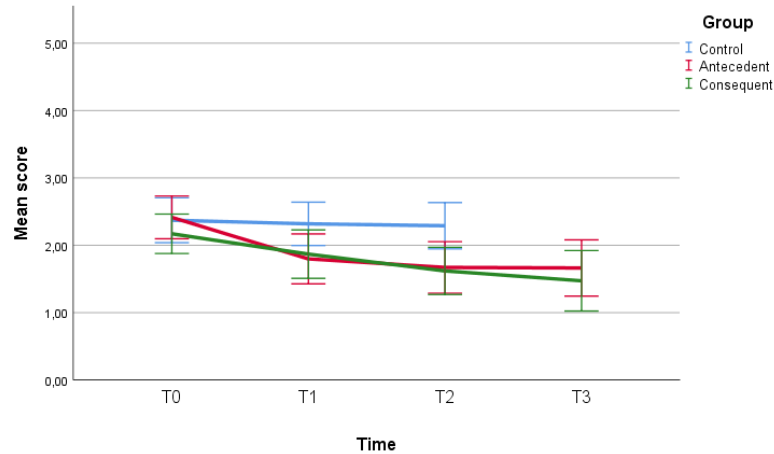
Sensitivity analyses regarding type of daily rated problem behaviors effects were large for oppositional defiant behaviors (for the AC [ $n=22$ ] versus control [ $n=14$ ]:  $B=-.87$ ,  $SE=.28$ ,  $p<.01$ ,  $d=.73$ ; for the CC [ $n=18$ ] versus control:  $B=-1.23$ ,  $SE=.30$ ,  $p<.001$ ,  $d=1.03$ ). For daily rated problem behaviors related to hyperactive-impulsive behavior effects were medium (for the AC [ $n=17$ ] versus control [ $n=24$ ]:  $B = -.59$ ,  $SE=.28$ ,  $p<.05$ ,  $d=.55$ ), and small (for the CC [ $n=15$ ] versus control:  $B=-.41$ ,  $SE=.31$ ,  $p<.05$ ,  $d=.35$ ). Effects on daily rated problem behaviors related to inattention were medium (for the AC [ $n=19$ ] versus control [ $n=24$ ]:  $B=-.69$ ,  $SE=.27$ ,  $p<.01$ ,  $d=.65$ ), and not significant (for the CC [ $n = 22$ ] versus control:  $B = -.07$ ,  $SE=.25$ ,  $p=.79$ ,  $d=.07$ ).

**Table 2.** Effects of the active conditions compared to the control condition, and compared to each other, on primary and secondary outcomes on different time points

	T0 vs T1		T0 vs T2	
Daily rated problem behaviors	<i>B (SE)</i>	<i>d (95% CI)</i>	<i>B (SE)</i>	<i>d (95% CI)</i>
AC vs. control	<b>-.56 (.19)*</b>	.59 (.07;1.11)	<b>-.65 (.19)**</b>	.66 (.14;1.18)
CC vs. control	-.33 (.19)	.35 (-.16;.86)	<b>-.53 (.19)**</b>	.54 (.02;1.06)
AC vs. CC	-.23 (.19)	.24 (-.27;.75)	-.12 (.19)	.12 (-.39;.63)
Hyperactivity-impulsivity symptoms (SWAN)	<i>B (SE)</i>	<i>d (95% CI)</i>	<i>B (SE)</i>	<i>d (95% CI)</i>
AC vs. control	-.88 (1.49)	.12 (-.45;.69)	<b>-3.93 (1.44)**</b>	.59 (.03;1.15)
CC vs. control	-2.30 (1.45)	.33 (-.24;.90)	<b>-2.80 (1.42)*</b>	.42 (-.10;.94)
AC vs. CC	1.42 (1.53)	-.20 (-.76;.37)	-1.12 (1.49)	.17 (-.38;.72)
Symptoms of inattention (SWAN)	<i>B (SE)</i>	<i>d (95% CI)</i>	<i>B (SE)</i>	<i>d (95% CI)</i>
AC vs. control	<b>-2.54 (1.26)*</b>	.39 (-.12;.90)	<b>-2.13 (1.22)*</b>	.34 (-.17;.85)
CC vs. control	-1.44 (1.32)	.22 (-.29;.73)	1.04 (1.20)	-.17 (-.68;.34)
AC vs. CC	-1.10 (1.39)	.17 (-.34;.68)	<b>-3.17 (1.26)*</b>	.51 (-.00;1.02)
ODD symptoms (DBDRS)	<i>B (SE)</i>	<i>d (95% CI)</i>	<i>B (SE)</i>	<i>d (95% CI)</i>
AC vs. control	-1.16 (.91)	.25 (-.26;.76)	-1.45 (.91)	.32 (-.19;.83)
CC vs. control	-.13 (1.88)	.03 (-.48;.54)	1.19 (.88)	-.27 (-.78;.24)
AC vs. CC	-1.04 (.94)	.22 (-.29;.73)	<b>-2.64 (.95)**</b>	.59 (.07;1.11)

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

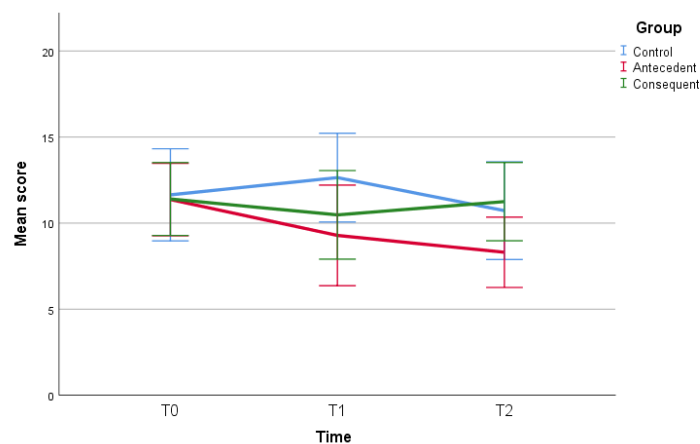
All analyses were controlled for baseline scores, effect sizes were calculated on the SD of the specific time point. A negative score indicates a decrease in behaviors and symptoms (parent-rated). AC = antecedent-based condition; CC = consequent-based condition; ADHD = attention-deficit/hyperactivity disorder; SWAN = Strengths and Weaknesses of ADHD symptoms and Normal behavior rating scale; DBDRS = Disruptive Behavior Disorder Rating Scale; ODD = oppositional defiant disorder.



**Figure 2.** Mean scores of daily rated problem behaviors for the three conditions over time. Scores are means across four problem behaviors measured on five consecutive days.  
*Note.* Error bars represent 95% confidence intervals.

### Secondary outcomes: parent-rated ADHD and ODD symptoms

Regarding our secondary outcomes (Table 2), hyperactivity-impulsivity symptoms (SWAN) significantly decreased in both active conditions from T0 to T2, compared to the control condition. For symptoms of inattention (SWAN), we found a significant decrease only in the AC compared to the control condition from T0 to T1, and from T0 to T2, but not in the CC compared to the control condition for both comparisons. For symptoms of inattention, the AC and CC significantly differed from each other at T2 (Figure 3). Regarding ODD symptoms (DBDRS), no significant effects of both active conditions compared to the control condition were found.



**Figure 3.** Mean scores of symptoms of inattention (Strengths and Weaknesses of ADHD symptoms and Normal behavior rating scale) for the three conditions over time.  
*Note.* Error bars represent 95% confidence intervals.

## **Moderators**

None of the child and parent characteristics moderated treatment outcome regarding our primary outcome measure. Results (Table S3), and the correlation matrix of the assessed characteristics and outcome variable (Table S4) can be found in Appendix V.

## **Consumption of mental health care between T2 and T3**

Regarding medication use between T2 and T3, 6 children (20.7%) in the AC had started with psychopharmacological treatment, versus 9 children (28.1%) in the CC. These proportions did not statistically differ from each other ( $\chi^2=.45$ ,  $p=.562$ ). Regarding non-pharmacological care for parents, parents of 3 children (10.3%) in the AC received additional parent training, counseling or support ( $M=5.00$  sessions,  $SD=4.36$ ). In the CC parents of 5 children (16.1% [ $M=12.60$  sessions,  $SD=17.14$ ]) received additional help. Given the small sample size, Fisher's exact test was run; the difference in proportions was not significant ( $p=.708$ ). The CC included one family that received an intensive multi-family treatment, with 43 sessions in total. Without this case, the mean number of sessions with parents in the CC was 5.00 (equal to AC;  $SD=2.58$ ). With respect to non-pharmacological care for the child, 4 children (13.8%) in the AC received additional therapy or training ( $M=2.75$  sessions,  $SD=1.26$ ), versus 4 children (12.9%) in the CC ( $M=5.00$  sessions,  $SD=4.96$ ), Fisher's exact test showed that the difference in proportions was not significant ( $p=.998$ ).

## **Discussion**

This was the first randomized controlled microtrial into the effects of antecedent-based and consequent-based techniques of BPT programs for children with ADHD. We also explored whether a number of different child and parent characteristics moderated the efficacy of these techniques. Our results indicate that, compared to waitlist, both sets of techniques were effective in decreasing individualized daily rated problem behaviors (medium effects sizes), and resulted in greater proportions of children who achieved clinically significant change. Changes in daily rated problem behaviors were persistent up to three months follow-up. While both techniques were effective in reducing hyperactive/impulsive symptom ratings, the antecedent-based techniques were more effective than the consequent-based techniques in

decreasing symptoms of inattention. Consistent with these findings, we found that the daily rated problem behaviors concerning inattentive behaviors improved only using antecedent-based techniques, in contrast to the consequent-based techniques. We did not find moderating effects of the demographic and baseline characteristics.

Overall, the differences in efficacy between the AC and CC were small, but the antecedent-based techniques caused the daily rated problem behaviors to decrease immediately, whereas the consequent-based techniques were not effective directly after the sessions, but only two weeks after the sessions. It may be that learning to apply consequent-based techniques requires more of parents' time and effort than antecedent-based techniques (Roberts, Tingstrom, Olmi, & Bellipanni, 2008). Usually, parents have been reacting to their children's behavior in a certain manner for a long time and it may be difficult for them to change these ingrained coercive patterns. In addition, consequent-based techniques require a certain level of observational skills of parents (i.e., evaluating whether behavior is desired or undesired), whereas antecedent-based techniques can be implemented regardless of child behavior. In accordance to this, consequent-based techniques may also take more time to influence behaviors of the child (Owen, Slep, & Heyman, 2012). Antecedent-based techniques focus on the prevention of problem behavior, possibly showing direct effects, whilst changes in the contingencies of behaviors requires repeated exposure of children to the changed behavioral consequences before adapting their behavior (Owen et al., 2012). This delayed learning effect in the CC may be specifically pronounced in children with ADHD, as experimental research shows that children with ADHD adjust their behavioral responses to changes in reinforcer availability (such as provided in the CC) less efficiently and slower than their typically developing peers (Alsop et al., 2016; Furukawa et al., 2017; Furukawa, Alsop, Shimabukuro, & Tripp, 2019). Moreover, although in the antecedent-based training we did not inform parents about reinforcement strategies, training in antecedent-based techniques may have elicited the use of consequent-based techniques by parents. For example, training parents in defining rules and giving clear instructions may elicit better compliance of the child, which can evoke the use of praise and positive attention from parents. However, as we did not directly observe the behavior of parents at home in our study, we cannot be sure if this was the case.

The more direct effect of the AC as compared to the CC, was somewhat different from the results of our randomized controlled microtrial into effects of behavioral teacher training for children with ADHD. In our teacher training microtrial both types of techniques were equally and highly effective directly after the training (Staff et al., 2020). It may well be that the coercive cycle, i.e., the escalation of negative child and parental behavior via reinforcement processes, is more pronounced and fixed within the parent-child relationship (Granic & Patterson, 2006). In the teacher-child relationship, the coercive cycle is also a well-established pattern, however, it might be less embedded and therefore easier to change (Atkins et al., 2002).

Regarding our secondary outcomes, both sets of techniques improved hyperactivity-impulsivity symptoms, but antecedent-based techniques were more effective than consequent-based techniques on symptoms of inattention. In accordance to this, our sensitivity analyses showed that the daily rated problem behaviors concerning inattentive behaviors improved using antecedent-based techniques, in contrast to the consequent-based techniques. A possible explanation for the stronger effects of the antecedent-based techniques on inattention could be that through the use of these types of techniques poor executive functions of children with ADHD are being supported (Antshel & Barkley, 2008; Chacko et al., 2014). If a child has trouble regulating behavior, assisting the child with external cues and clear information (i.e., defining rules, giving clear instructions, anticipating misbehaviors, and providing structure in time and space) is needed (Barkley, 2012). Also, if the context is too distractive and the salience of the reinforcement is not significant enough, it may be difficult for the child to learn from the consequences of behavior (Van der Oord & Tripp, 2020). It may thus be that antecedent-based techniques have to be implemented first to optimize the efficacy of consequent-based techniques. Future studies on the sequence or combination of different components and techniques are required. For example, by using factorial designs to gain more insight into interactions between components (Collins et al., 2005) or single-case experimental designs to examine different combinations of components (Kazdin, 2019).

Regarding ODD symptoms, both sets of techniques did not significantly reduce oppositional defiant symptoms as measured with the DSM-IV based ODD items of the DBDRS questionnaire. However, we did find large effects of both antecedent-based and consequent-based techniques on more specific daily



rated oppositional defiant behaviors (e.g., often angry at breakfast) than DSM-IV based generic ODD items, probably due to the higher sensitivity and specificity of our primary outcome, the proximal EMA measures. These findings highlight the importance of targeting specific behaviors with a tailored plan of techniques, to meet the needs of specific families and children with ADHD (Van der Oord & Tripp, 2020).

The effect sizes of our outcomes were comparable to the effect sizes of complete training programs (e.g., Daley et al., 2014,  $d=.35$ ). It may be that the use of intervention plans that were individually tailored to problem behaviors that were particularly troublesome for parents has added to the efficacy of the techniques. Problem behaviors were selected on the basis of functional behavioral analysis, in which the therapist identified the specific factors that triggered problem behaviors (in the AC) or maintained the occurrence of the behaviors (in the CC) (Pfiffner & Haack, 2014). The finding that this approach appeared effective may highlight the importance of tailoring interventions to the specific needs of parents and children (Leijten et al., 2015). Furthermore, the short and focused character of both training formats could be a potential factor contributing to their efficacy. It may be more feasible, motivating and reinforcing for parents to focus on the implementation of techniques on one specific behavior in a situation, than to learn a variety of different techniques over a longer period of time. As heritability in ADHD is high (Larsson, Chang, D'Onofrio, & Lichtenstein, 2014), this may be especially true for parents of children with ADHD, who may have similar working memory, attention, and motivational problems as their children (Dentz, Romo, Konofal, & Parent, 2016; Starck, Grünwald, & Schlarb, 2016). Moreover, enrollment and engagement in a longer BPT program is often problematic (Chacko et al., 2016). In the current study, dropout was very low (4%), which may highlight the acceptability and feasibility of short training programs as first line interventions (Coles et al., 2019). Another factor that may have contributed to the efficacy of our short programs is that practicing during the sessions seems to be an important component contributing to the effectiveness of BPT programs (Kaminski, Valle, Filene, & Boyle, 2008). In both training conditions of our study, practicing the specific techniques with parents directly in the situation in which they were going to apply them was a crucial part of the sessions. In future research, contrasting short individualized interventions to full BPT programs would be an interesting avenue.

Furthermore, mental health care consumption three months after the training was low. In both the AC and the CC, approximately a quarter of the children started with medication within three months after the training, which appears to be lower than in studies reporting on usual practices: of children who were being treated for ADHD symptoms by their general practitioner, 48.1% received medication (Prins & Van Dijk, 2015). Also in the community care group of the Multimodal Treatment Study of Children With ADHD (MTA; MTA Cooperative Group, 1999) the proportion of children who started with medication within 14 months was larger (67.4%). However, in our study, we assessed mental health care consumption after three months, so these findings may not be comparable to the much longer assessment period in the MTA study. Even so, the numbers of parents and children who received additional mental health care was low in both active conditions, suggesting that the short, focused training in techniques potentially reduced the need for additional treatment.

### **Limitations**

The results of this microtrial should be interpreted in light of some limitations. First, we examined the efficacy of the techniques on individualized daily rated problem behavior, as rated by parents. Parents received the training, and inherent to this, could not be masked to the conditions, which may have caused an overestimation of the rated effects (Daley et al., 2014). However, the use of individual daily rated problem behavior using the EMA method adds to the ecological validity of our study, and reduces potential recall or memory bias (Russell & Gajos, 2020). Future research can possibly overcome this limitation by using more masked outcome measures, such as audiotaped assessments of parent-child interactions at home (e.g., Herbert, Harvey, Roberts, Wichowski, & Lugo-Candelas, 2013). Second, because we examined the sets of techniques as separate entities, we cannot make statements about the combined or additional efficacy of the techniques in samples of children with ADHD. In addition, some techniques may be more effective or dependent on the installation of other techniques. Third, it could be that the different intervention components have different proximal outcomes, which could also be parenting behaviors. Furthermore, within the AC and the CC specific types of antecedent-based or consequent-based techniques (e.g. ignoring vs reward) could potentially be differentially effective on different behaviors and this information may be of importance in further fine-tuning interventions

(Pfiffner, Rosenberg, & O’Leary, 1985; Rosén, O’Leary, Joyce, Conway, & Pfiffner, 1984). Factorial experiments, as proposed by Collins and colleagues (Collins et al., 2005), would be a useful additional approach to examine interactions between the different techniques and different proximal outcomes. Eventually, triangulating across different designs may be necessary to provide the most informative conclusions. Fourth, ideally, future research could include more daily assessments to potentially increase power and to examine, at a more detailed level, when change occurred. However, clinical feasibility of collecting more data in groups of parents of children with ADHD may be difficult (Miguel-Fernandez et al., 2018). Fifth, although our sample seems to be comparable to other clinical samples of children with ADHD regarding sex distribution (Bauermeister et al., 2007), ADHD symptom severity (Burton et al., 2019), and comorbidity with ODD (Reale et al., 2017), children were predominantly Caucasian, which may limit the generalizability of our results to more diverse groups. Last, we found no significant moderating effects regarding characteristics of the child and parent for the different sets of techniques, possibly due to the relatively low number of participants. Because of the experimental and focused character of microtrials, a smaller sample size can be sufficient to detect possible moderating effects, compared to other designs such as field studies and randomized trials (Howe & Ridenour, 2019; Staff et al., 2020). Ideally, the selection of moderators should be theoretically grounded. Given the lack of literature on moderators of effects of specific treatment techniques this was unfortunately not possible for the current moderator analyses. These were therefore rather exploratory.

### **Clinical implications**

Taken together, the results of this study indicate that brief training of parents in antecedent-based or consequent-based techniques yields robust effects on targeted problem behaviors of children with ADHD. In BPT programs for children with ADHD, antecedent-based techniques may be of particular importance to target inattentive symptoms. Furthermore, it may be advisable to start training programs with antecedent-based techniques, as these seem to have more immediate effects than consequent-based techniques. These immediate effects may enhance parental motivation to complete BPT programs, as parents will experience success in the beginning of the treatment (Pereira & Barros, 2019). Although originally we intended to study whether certain techniques should have more or less emphasis in full

BPT programs, the efficacy and low dropout rates of our short individualized training formats also suggests that such interventions may be considered as stand-alone initial treatments for children with ADHD, after which other more intensive treatment options can be considered.