Journal of the American Academy of Child and Adolescent Psychiatry

The impact of behavioral interventions for children and adolescents with attention-deficit hyperactivity disorder: A meta-analysis of randomized controlled trials across multiple outcome domains

--Manuscript Draft--

Manuscript Number:	JAACAP-D-13-00557R2
Full Title:	The impact of behavioral interventions for children and adolescents with attention-deficit hyperactivity disorder: A meta-analysis of randomized controlled trials across multiple outcome domains
Short Title:	Behavioral interventions for ADHD
Article Type:	Review Article*
Keywords:	ADHD; parenting; intervention; Conduct
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Manuscript Region of Origin:	UNITED KINGDOM
Abstract:	Abstract Objective: Behavioral interventions are recommended as ADHD treatments. However, a recent meta-analysis found no effects on core ADHD symptoms when raters were probably blind to treatment allocation. Here, this analysis is extended to a broader range of child and parent outcomes. Method: A systematic search in Pubmed, Ovid, Web of Knowledge, ERIC, and CINAHAL databases (up to February 5th, 2013) identified published randomized controlled trials measuring a range of patient and parent outcomes for children and adolescents diagnosed with ADHD (or who met validated cut-offs on rating scales). Results: Thirty two of 2057 non-duplicate screened records were analyzed. For assessments made by individuals closest to the treatment setting (usually unblinded) there were significant improvements in parenting quality (standardized mean difference (SMDpositive parenting = 0.68; SMDnegative parenting = 0.57) and parenting self-concept (SMD=0.37) as well as child ADHD (SMD = 0.35), conduct problems (SMD = 0.26), social skills (SMD = 0.47) and academic performance (SMD= 0.28). With probably blinded assessments significant effects persisted for parenting (SMDpositive parenting = 0.63 and SMDnegative parenting=0.43) and conduct problems (SMD =

	0.31). Conclusions: In contrast to the lack of blinded evidence of ADHD symptom reduction, behavioral interventions have positive effects on a range of other outcomes when used with ADHD patients. There is blinded evidence that they improve parenting and reduce childhood conduct problems. These effects may also feed through into a more positive parenting self-concept but not improved parent mental wellbeing.

Dear Steve,

Thank you for accepting our publication in JAACAP subject to the resolution of some additional matters. Please find below our response in relation to each matter raised. 1) *Title Page: *The editors recommend changing the title to "Behavioral interventions in attention-deficit/hyperactivity disorder: A meta-analysis of randomized controlled trials across multiple outcome domains." Please review, and if this is acceptable, update the title in your revised submission.*

We have amended the title as requested.

2) *Provide the degree and institutional affiliations/employers for the persons mentioned in your acknowledgements paragraph (the EAGG members) by including them after their respective names (ex. "The authors wish to thank John Smith, Ph.D., of the University of Chicago for assistance in manuscript preparation").*

We have amended the affiliations

3) Create an author affiliations paragraph, rather than list the affiliations in a footnoted format. Please add the paragraph to title page, including affiliations for all authors.

We have added an affiliations paragraph for authors

4) *References: Authors listed in reference list / tables / figures do not always match. Please review references and citations for consistency*.

We have corrected the references

5) *Review your manuscript for the correct use of N vs. n when referring to numbers of individuals in a study. N is used when referring to the entire sample; n refers to a subsample.*

We have corrected sub-sample n's where needed

6) *Be sure to use 'person-first' language throughout the text, e.g. replace "asthmatic person" with "a person with asthma."*

We have corrected the text to ensure first person language is used through out

7*) The structured abstract for research articles should be a maximum of 250 words and must be formatted with sections entitled as follows: Objective, Method, Results, and Conclusions. Please update your abstract accordingly*.

We have amended the abstract

8*) Please replace any ampersands (&) with "and" throughout your manuscript.*

We have replaced ampersands throughout the manuscript

9*) Optional: Add a brief paragraph, titled 'Clinical Guidance,' to your Discussion section. It should be a bulleted list, no longer than 150 words, summarizing three or four key 'take-home' points practicing*

clinicians should distill from your study. Ideally, this will be geared toward front-line, busy clinicians, as opposed to specialists focused on the details of research. Please note that the word count limitations will be relaxed to accommodate this feature.

We have decided not to include a clinical guidance section to the manuscript. The reason for this is that the clinical implications of our findings are complex and require extensive discussion within the broader EAGG group. This discussion has not taken pace as yet. Our longer term goal is to producea separate guideline publications giving treatment recommendations for clinicians in the future.

10) Please create a supplemental reference list containing the citations used in the supplemental materials. In Table S1, add superscript numbers to the study references that correspond to the reference list.

We have amended the tables as requested

11) Text states that 9 studies had a Jadad study quality rating of three or more (Results section), but Table 1 only shows 7 studies with 3 or higher quality ratings. Please clarify and verify throughout manuscript.

This has been amended

*12) *In Figure 1, please add a comma to numbers with 4 or more digits (ex: 1,234).*

Commas have been added as requested

13) Each figure should be on a separate page and uploaded as a separate document. Label each figure file with the name of the author and figure number, i.e. Jensen-Figure 1.eps.

**Titles and captions for figure(s) should be placed on a separate page of the manuscript file (place wording for all figures on one page). Remove titles and captions from the figure images.*

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Each figure is now formatted and presented as requested

14) *Supplemental Material:*
**Clarify definition of excluded studies (i.e. what is meant by "no appropriate control," etc?)*

**Some studies are listed in both inclusion and exclusion lists. Please clarify.*

We have now amended the supplementary material and have given explicit reasons why studies did not meet our inclusion criteria.

15) *A reviewer noted that several published studies of behavioral interventions do not appear in either list of included and excluded studies. Please review attached list of studies and clarify.*

We have examined these additional studies with great care. While some studies were published after our search date, some do not meet our criteria – these we did not include in our meta-analysis. However, four additional studies did meet our criteria and we have been able to include three of them in our analysis (For one the necessary data was not made available by the authors). After the inclusion of these three extra trials in our meta-analysis our results and interpretation remain unchanged with the exception that the SMD for conduct problems PBLIND increased in size and moved from marginal to full significance. Text, figures and tables and supplemental material have been amended to account for the inclusion of these additional trials. We have added an acknowledgement to the reviewer in our acknowledgements for bringing these additional studies to our attention.

Yours sincerely

David Daley & Edmund Sonuga-barke

Title Page including all author information

The impact of behavioral interventions for children and adolescents with attention-deficit hyperactivity disorder: A meta-analysis of randomized controlled trials across multiple outcome domains

David Daley PhD, Saskia van der Oord PhD, Maite Ferrin MD PhD, Marina Danckaerts MD PhD, Manfred Doepfner PhD, Samuele Cortese MD PhD & Edmund JS Sonuga-Barke PhD on behalf of the European ADHD Guidelines Group

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Word count

Abstract – 246

Text – 3695

References – 1792

Tables - 1034

Acknowledgements

EAGG (European ADHD Guidelines Group) is a workgroup of the European Network for Hyperkinetic Disorder (Eunethydis) and consists of the following members and associates co-opted to work on this review (listed in alphabetical order): T. Banaschewski, J. Buitelaar, D. Brandeis, D. Coghill, S. Cortese, D. Daley, M. Danckaerts, R. W. Dittmann, M. Döpfner, B. Falissard, M. Ferrin, J. Graham, R. Hamilton, C. Hollis, M. Holtmann, M. Hulpke-Wette, M. Lecendreux, E. Konofal, P. Santosh, E. Rosenthal, A. Rothenberger, J.A. Sergeant, E. Simonoff, E.J. Sonuga-Barke, H-Ch. Steinhausen, J. Stevenson, A. Stringaris, E. Taylor, M. Thompson, S. van der Oord, I. Wong, and A. Zuddas.

We would wish thank the following individuals who supplied information and advice; Howard Abikoff PhD, New York University, USA; Russell Barkley PhD, Medical University of South Carolina, USA; Bazian Ltd, UK; Steve Evans PhD, University of Ohio, USA; Greg Fabiano PhD, Buffalo State University, USA; Philip Firestone PhD, University of Ottawa Canada; Nicholas Ialongo PhD, Johns Hopkins University USA; Linda Pfiffner PhD, University of California, San

Francisco, USA; Thomas Power PhD, University of Pennsylvania, USA; Mary V Solanto PhD, Mount Sinai School of Medicine USA; Jim Stevenson PhD, University of Southampton, UK and Jim Swanson PhD, University of California, Irvine USA; Barbara Van den Hoofdakker PhD, University of Groningen, Netherlands and the anonymous reviewers who provided invaluable feedback. We are also grateful for the support given by Jana de Vos MSc and Stephanie Kristensen MSc KU Leuven, Belgium and Jo Lockwood B.A, University of Nottingham, UK.

Conflicts of Interest

Samuele Cortese - Dr Cortese has served as scientific consultant for Shire Pharmaceuticals from June 2009 to December 2010. He has received support to attend meetings from Eli Lilly and co in 2008 and from Shire in 2009-2010. There are no further conflicts of interest.
David Daley has provided educational talks for Lilly and Shire, has attended an advisory board for Lilly, has received support for educational travel from Lilly, Shire and HP Pharma and currently holds funding from Shire. Marina Danckaerts - Speaker's bench: Janssen-Cilag, Lilly, Shire, Novartis, Medice. Funding for clinical trials: Lilly, Shire. Educational grant: Shire. Marina Danckaerts has been involved in the development and dissemination of an ADHD-Toolkit for teachers in primary school, distributed to all primary schools in Belgium by the Minister of Education and had been a consultant for Janssen Pharmaceuticals for the development and evaluation of serious game "Healseeker" which is aimed at training cognitive funcitons
Manfred Döpfner - research support, advisory board or speaker: Janssen-Cilag, Medice, Vifor, Shire, Lilly, Novartis. he has been involved in the development, evaluation and dissemination of the German Therapieprogramm für Kinder mit hyperkinetischem und oppositionellem Problemverhalten (THOP) and Präventionsprogramm für Expansives Problemverhalten (PEP), which are behavioral interventions for children with ADHD. He is also head, supervisor and lecturer at the School of Child Behavior Therapy at the University of Cologne. He has received royalties for treatment manuals (Beltz, Hogrefe Publisher) and as supervisor and lecturer and as consultant of the German Kassenärztliche Bundesvereinigung for the evaluation of behavior therapy. He is conducting an on-going trial on the effects of Omega-3/6 fatty acids supported by

Vifor Pharma and several trials on the effects of behavioral interventions for children with ADHD supported by the German Research Foundation, German Ministry of Education and Research, Shire, Lilly.

Maite Ferrin is a grant recipient for travel expenses from Alicia Koplowitz Fundation, Instituto de Salud Carlos III (ETS 07/90902, BAE 09/90088) and Gobierno de Navarra (Beca Jeronimo de Ayanz 2011/12). She declares no other conflict of interest.

Edmund J S Sonuga-Barke has been involved in the development, implementation and trialing of the New Forest Parenting Programme for preschool children with ADHD and has received royalties from sales of a New Forest Parent Training self help manual. Recent speaker board: Shire, UCB Pharma, Janssen Cilag, Medice. Current & recent consultancy: UCB Pharma, Shire. Current & recent research support: Shire. Advisory Board: Shire, Flynn Pharma, Astra Zeneca. Conference support: Shire.

Saskia van der Oord has been involved in the development, implementation and trialing of 1) “Braingame Brian”, executive functioning game training for children with ADHD and 2) “Zelf Plannen” a cognitive behavioral planning intervention for adolescents with ADHD. She has no financial interests in any of these interventions. Further, she has been a paid consultant for Janssen Pharmaceuticals, for the development and evaluation of a serious game “Healseeker”, which is aimed at training cognitive functions.

Abstract

Objective: Behavioral interventions are recommended as ADHD treatments. However, a recent meta-analysis found no effects on core ADHD symptoms when raters were probably blind to treatment allocation. Here, this analysis is extended to a broader range of child and parent outcomes.

Method: A systematic search in Pubmed, Ovid, Web of Knowledge, ERIC, and CINAHAL databases (up to February 5th, 2013) identified published randomized controlled trials measuring a range of patient and parent outcomes for children and adolescents diagnosed with ADHD (or who met validated cut-offs on rating scales).

Results: Thirty two of 2057 non-duplicate screened records were analyzed. For assessments made by individuals closest to the treatment setting (usually unblinded) there were significant improvements in parenting quality (standardized mean difference(SMD)$^{positive\ parenting}$ = 0.68; SMD$^{negative\ parenting}$ = 0.57) and parenting self-concept (SMD=0.37) as well as child ADHD (SMD = 0.35), conduct problems (SMD = 0.26), social skills (SMD = 0.47) and academic performance (SMD= 0.28). With probably blinded assessments significant effects persisted for parenting (SMD$^{positive\ parenting}$ = 0.63 and SMD$^{negative\ parenting}$=0.43) and conduct problems (SMD = 0.31).

Conclusions: In contrast to the lack of blinded evidence of ADHD symptom reduction, behavioral interventions have positive effects on a range of other outcomes when used with ADHD patients. There is blinded evidence that they improve parenting and reduce childhood conduct problems. These effects may also feed through into a more positive parenting self-concept but not improved parent mental wellbeing.

Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is characterised by age inappropriate, persistent, and pervasive inattention and/or over-activity/impulsiveness which impairs daily functioning[1] and is associated with substantial long term burden on patients, families and health and educational services[2,3]. Multi-modal treatment approaches are recommended[4]. Medication is typically used as the first line intervention, especially for severe cases[5]. Despite robust evidence of medium-term symptom control[6], medication has a number of limitations. A proportion of patients show partial or no response[6]. Long-term effectiveness remains to be established[7,8]. Important aspects of functioning may not improve (e.g., academic achievement[9]). Adverse effects on sleep, appetite and growth, though rarely serious and generally manageable, are common and may not be well tolerated[10]. Treatment compliance can be low especially during adolescence[11]. Finally, parents and clinicians can have reservations about medication use[12] and may prefer non-pharmacological approaches[13].

Interventions employing behavioral techniques are also recommended and commonly used as ADHD treatments[14]. Systematic reviews of treatment trials have provided evidence to support their efficacy[15,16,17]. However, these reviews can be difficult to interpret as they sometimes include non-randomized controlled trials (RCT's), mix individuals with and without ADHD and have not always drawn clear boundaries between ADHD-specific and other outcomes. Furthermore, outcome assessment is often made unblinded by individuals taking an active part in the intervention (e.g., parents receiving parent training), which is likely to inflate efficacy estimates[18]. Sonuga-Barke et al. published a meta-analysis of randomized controlled trials (RCT) of behavioral interventions[19]. Stringent inclusion and exclusion criteria addressed some of the limitations of previous meta-analyses. There was a moderate, statistically significant positive effect on ADHD core symptoms for assessments made by individuals *most proximal* to the therapeutic setting - typically unblinded parent ratings. However, these effects were not corroborated by *probably blinded* measures made either by observers or raters unaware of treatment allocation where the effect size dropped

to near zero and became non-significant. A similar, though less marked reduction, was found for neuro-feedback and cognitive training. There are a number of possible explanations for these findings. First, that unblinded raters are biased and overestimate treatment effects[20]. Second, that interventions increase either parental tolerance for ADHD or their ability to cope with its negative impact rather than reducing symptom levels[19]. Third, that *probably blinded* measures were less valid than most proximal measures[21]. Finally, that intervention effects did not generalize from the therapeutic setting (e.g., the home) to other settings (e.g., school)[22]. The authors concluded that more evidence from studies with blinded assessments is required before behavioral interventions can be supported as treatments for core ADHD symptoms.

The limited effects of behavioral approaches on blinded core ADHD measures may be explicable if one considers the treatment models upon which many are based. For instance, although most treatments in the trials included in the Sonuga-Barke et al.[19], meta-analysis were implemented to target ADHD symptoms they were initially developed, and have been used extensively, for children with oppositional and conduct problems[23, 24, 25]. For many of these the rationale is that children's challenging behavior develops because of coercive interactional cycles which, over-time, co-reinforce non-compliant and oppositional behaviors in the child and negative and inappropriate responses from significant adults (usually the parent but also potentially teachers and other care givers) [26]. During intervention the adult is taught to apply behavior modification techniques to reinforce appropriate and extinguish inappropriate child behaviors, enhance effective and enjoyable adult-child interactions[27] and so transform negative into positive interactional cycles. Such interventions, it could be argued, are unlikely to be effective as treatments for core ADHD symptoms because ADHD does not emerge via a similar environmentally mediated route as conduct problems and is therefore less likely to respond to the modification of environmental contingencies[28].

However, the value of behavioral interventions does not rest exclusively on their potential effects on ADHD symptoms. Patients with ADHD often have conduct problems[29]

and other comorbidities[30] as well as poor social and organisational skills and low academic achievement. Their parents can suffer from poor parenting self-concept and mental health problems[31]. These associated features of the disorder are important treatment targets in and of themselves as each is associated with substantial burden to the child, their family and society via the criminal justice, social and health systems[22, 32]. Behavioral interventions may have an important role in treating these problems whether or not they reduce core ADHD symptoms. Indeed behavioral treatments used with patients with ADHD have targeted such ADHD-related but non-specific aspects of impairment rather than ADHD symptoms themselves (e.g., social skills [33]; organisational skills [34]; academic achievement [35]).

In this paper we build on the previous meta-analysis[19] to address this broader impact of behavioral interventions for children with ADHD. We address three related questions. First, given that most, though not all, interventions are implemented via changes in the behaviour of responsible adults (typically either parents or teachers), do behavioral interventions improve adult responses to children with ADHD? Second, do they improve the sense of efficacy and competence and reduce the mental health problems of adults working with children with ADHD? Third, do they reduce levels of child oppositional behaviour and other comorbidities and other aspects of impairment such as social skills and academic performance? To address these questions *most proximal* and *probably blinded* assessments were once again contrasted.

Methods

Please see the registered protocol CRD42011001393 at (link deleted to blind the identity of the authors) for more details.

Inclusion Criteria: Only published peer reviewed RCTs were included although we also acknowledge that many well-designed studies using single-subject research designs examining the effects of behavioral interventions have been published. Following the recommendation of the Cochrane group we limited our search to published trials to ensure a level of methodological adequacy and rigour among included trials and to avoid the inevitable problems with securing access to a full set of unpublished trials and the bias that

this would introduce [36]. Participants needed to be between ages three and 18 years and have an ADHD diagnosis (any subtype) or have met accepted cut offs on validated ADHD rating scales. Trials just involving rare comorbid disorders (e.g., fragile X syndrome) were excluded. Acceptable control conditions were "treatment as usual", "wait list" or "active" controls. "Treatment as usual" could include medication, but trials were excluded if the behavioral intervention was an adjunct to medication or if both pharmacological and behavioral interventions were combined into one therapeutic arm as part of study design. For the present extended review, trials could be included despite not having an ADHD-related outcome (as required in the original protocol).

Search Strategy

The search was updated February 5th, 2013. SC and MF blindly conducted and cross-checked the updated search using the same databases, search strategy and search terms as used previously[19] (see protocol). The searches were conducted for records included from the inception of the data-bases. Behavioral interventions were defined as those interventions directed at changing behaviors (increasing desired and decreasing undesired behaviors).They encompass classical contingency management, behaviour therapy (mainly through mediators such as parents or teachers) and cognitive behaviour therapy (such as verbal self-instruction, problem solving strategies or social skills training). The treatment search terms covered a wide variety of intervention types with the aim of including trials involving any form of behaviorally-based therapies, implemented in any setting (home or school) either indirectly via an adult or directly to the child (see protocol).

Outcome Measures

To increase analytical robustness outcome domains were only considered if five or more RCTs were available. Outcome measures meeting this criterion were pre- to post-treatment changes in positive and negative parenting, parent mental health (e.g., anxiety, depression) and parenting self-concept (e.g., sense of competence and efficacy), child ADHD, conduct problems (i.e., negative and non-compliant behavior including symptoms of oppositional,

defiance and conduct disorders), social skills and academic achievement. There were too few RCTs (n < 5) to examine changes in teacher behavior and wellbeing, child impairment, internalizing problems, executive/organisational skills or more general measures of family functioning.

Study Selection

Articles' titles and abstracts were screened. Final inclusion was based on the full text. Trials were blindly double-coded for eligibility. Study quality was assessed by two independent raters according to the Jadad criteria[37£] (see table 1). These provide a rating for each trial in terms of standard definitions for randomization, blinding and treatment of missing data defined by Jadad and colleagues [37] Jadad scores for blinding were adapted for use with multiple outcomes so that studies with at least one blinded outcome yielded a score of 1 on this dimension. A score of three or more is regarded as indicating acceptable quality. Initial disagreements (N=4) were resolved by the coders through discussion without recourse to an independent arbitrator.

Data Extraction and Statistical Analysis

Trial information was entered into RevMan 5.1 (http://ims.cochrane.org/revman)[38]. Data extraction was independently rated by two authors. The SMD, mean pre- to post-treatment change minus the mean pre- to post-treatment control group change divided by the pooled pre-test standard deviation with a bias adjustment, was calculated[39]. SMDs for trials in each domain were combined using the inverse-variance method[36]. Given the inherent heterogeneity of studies, random-effects models were used. The I^2 statistic was calculated, a posteriori, to estimate between-trial SMD heterogeneity. *Most proximal* and *probably blinded* analyses were both performed for all domains except parent mental health, parenting self-concept, child social skills and academic outcomes where insufficient trials with *probably blinded* measures were available. Where multiple measures were available for an outcome we selected the one most frequently reported across included trials. For the *most proximal*

analysis parent ratings, if available, were used except for teacher-based interventions when teacher ratings or direct observations were preferred. *Probably blinded* assessments were £
made by an individual likely to be blind to allocation. In trials in which more than one such measure was available, the best blinded measure was selected. This only affected trials with a home-based element where direct observations by an independent researcher and teacher ratings were the *probably blinded* measure. In such cases we selected direct observation over teacher ratings. Sensitivity analyses examined: i) the impact of background ADHD medication use in trial samples for which at least three trials had less than 30% of participants receiving medications (i.e., were no/low medication trials) and; ii) the effects of outliers identified using funnel plots within REVMAN 5.1[38]. Meta-regression tested whether effect sizes were greater in lower quality trials according to Jadad[37]. For one study[34] two active treatment arms were suitable for analysis. Parents and Teachers Helping Children Organize (PATHKO) and Organizational Skills Treatment (OST) yielded similar results and so only one arm, PATHKO, which was considered the more standard behavioral intervention was included in the final analysis. For another study[40] outcomes were taken from three publications[40, 41, 42].

Results

Thirty two studies met entry criteria and had data amenable to analysis. Eight had a Jadad study quality rating of three or more[33]. Thirty one studies had a parent-based component implemented at home. Four had an additional school-based teacher focused element. Fourteen included direct intervention with the child. While most employed standard behavioral principles and targeted children's externalizing behaviours (ADHD, ODD, CD), some implemented specialised social (n=3), organisational (n=3) or academic skills (n=1). Figure 1 reports the trial selection flow chart. Tables 1 and 2 give information about included trials, and the measures used in each analysis respectively.

{figure 1}

{tables 1 & 2}

Do behavioral interventions improve adult responses to children with ADHD?

No trials measured responses to children with ADHD by adults other than parents (i.e., no teachers). Nine trials measured *positive parenting*. Three *most proximal* measures were parent rated - five were observational. Eight trials had *probably blinded* measures, all observational. For positive parenting, *most proximal* effects were significant (*SMD*=0.68; *95%CI*=0.27–1.09; see Figure 2 for forest plots). Effects were similar for *probably blinded* outcomes (*SMD*=0.63; *95%CI*=0.47–0.78). Heterogeneity was significant in both analyses ($\chi^{2\text{most proximal}}$=63.55; I^2 = 87%; p<0.01; $\chi^{2\text{probably blinded}}$=40.58; I^2=83%; p<0.01). Effects were unaffected by limiting the analyses to no/low medication trials (N=5; $SMD^{\text{most proximal}}$=1.23; *95%CI*=0.26–2.20; N=4 $SMD^{\text{probably blinded}}$= .89; *95%CI*=0.65–2.13) although heterogeneity remained high ($\chi^{2\text{most proximal}}$ = 28.35; I^2 = 89%; p< 0.01; $\chi^{2\text{probably blinded}}$= 23.29; I^2=87%; p <0.01). Removing outliers reduced effect sizes (N=2 $SMD^{\text{most proximal}}$=0.32; *95%CI*=-0.06–0.58; N=1 $SMD^{\text{probably blinded}}$=0.44; *95%CI* =0.14–0.75). Heterogeneity was no longer significant ($\chi^{2\text{most proximal}}$ =3.46; I^2=0%; p=0.48; $\chi^{2\text{probably blinded}}$=0.83; I^2=0%; p=0.66). Fourteen trials measured *negative parenting*. Nine *most proximal* measures were parent ratings (four observations and one speech sample). Eight studies met criteria for *probably blinded* assessments (seven observations and one speech sample). For negative parenting, effects were significant for both analyses ($SMD^{\text{most proximal}}$=0.57; *95%CI*=0.37–0.78; $SMD^{\text{probably blinded}}$ =0.43; *95%CI*=0.24–0.62). Heterogeneity was also significant ($\chi^{2\text{most proximal}}$=32.7; I^2=60%; p<0.01; $\chi^{2\text{probably blinded}}$=19.8; I^2=65%; p<0.01). *Most proximal* effects were unchanged when no/low medication trials were analysed (N=7; *SMD* = 0.57; *95%CI*=0.22–.92; χ^2=7.81; I^2 = 49%; p<0.01) but effects became non-significant for *probably blinded* outcomes (N= 6; *SMD*=0.42; *95%CI*=-0.07–0.91;χ^2=14.25; I^2=72%; p<0.01). When outliers were excluded effects remained significant for both outcomes (N=2 $SMD^{\text{most proximal}}$=0.45; *95%CI*=0.31–0.58; N=1 $SMD^{\text{probably blinded}}$=0.36; *95%CI*=0.12–0.60). Heterogeneity was reduced for one ($\chi^{2\text{most proximal}}$=15.45; I^2 = 35%; p=.12) but not the other ($\chi^{2\text{probably blinded}}$=15.03; I^2 = 73%; p<0.01).

Do behavioral interventions improve the self-concept and mental health of adults working with children with ADHD?

No trials measured the self-concept and mental health of adults other than parents. Seven trials included self-ratings of parental self-concept (six parenting efficacy/sense of competence, one parenting self-esteem). There was a small but significant improvement in self-concept following treatment (*SMD*=0.37; *95%CI*=0.03–0.70). Heterogeneity was significant (χ^2=19.03; I^2=68%; p<0.01). Effects increased slightly in no/low medication trials (n=5; *SMD*=0.68; *95%CI*=0.22–0.92) while heterogeneity reduced substantially (χ^2=0.99; I^2=0%; p=0.61). When outliers were removed (n=1) effects and their heterogeneity were reduced to non-significant levels (*SMD*=0.30; *95%CI*=-0.07–0.65; χ^2=5.24; I^2=4%; p=0.39). Measures of self-rated parent mental health were included in nine studies (seven depression/anxiety; two more general well-being). There were no significant effects of treatment (*SMD*=0.09, *95%CI*=-0.09–0.23 – no/low medication analysis n=6; *SMD*=0.09; *95%CI*=-0.19–0.37; p=0.13; χ^2=5,63; I^2=47%; p<0.01). No outliers were identified.

{figure 2}

Do behavioural interventions reduce child psychopathology and improve functioning?

Nineteen studies had *most proximal* ADHD measures (four in addition to the trials included in Sonuga-Barke et al. [21]). The treatment effect was significant (*SMD*=0.35; *95%CI*=0.19–0.50). Heterogeneity was significant (χ^2=32.63; I^2=45%; p< 0.05). Restricting the analysis to no/low medication enhanced the effect (n=11; SMD= 0.50; *95%CI*=0.24–0.76) but heterogeneity remained significant (χ^2 =20.33; I^2=51%; p<0.05). Effects were reduced when outliers (n=3) were removed but remained significant (*SMD*=0.23; *95%CI*=0.12–0.35). Heterogeneity was no longer significant (χ^2=16.86; I^2=23%; p=0.21). None of the trials added

since Sonuga-Barke et al.[19] had a *probably blinded* measure so the prior finding of no treatment effect for ADHD remained unchanged (Overall SMD=0.02, 95% CI=–0.30-0.34). Fifteen trials had *most proximal* measures of conduct problems (ten parent, and three teacher ratings, and two clinic observations). Eight trials had *probably blinded* measures (one teacher and seven observational ratings). Both *most proximal* and *probably blinded* effects were significant (*SMD*= $0.26^{\text{most proximal}}$; *95%CI*=0.14–0.37; *SMD*=$0.31^{\text{probably blinded}}$; *95%CI*=-0.05–0.57). Heterogeneity was significant for most proximal (χ^2=25.87; I^2 = 46%; *p*=0.03) but not for probably blinded (χ^2= 14.28; I^2=51%; *p*=0.05). Low/no medication studies gave significant effects for both analyses (n=7; $SMD^{\text{most proximal}}$=0.54; *95%CI*=0.32–0.76; N=6; $SMD^{\text{probably blinded}}$=0.27; *95%CI*=0.02–0.51). Heterogeneity was not significant for either of these analysis ($\chi^{2\text{most proximal}}$= 5.96; I^2=37%; *p*=0.43; $\chi^{2\text{probably blinded}}$= 3.77; I^2=0%; *p*=0.44). *Most proximal* effects remained significant when outliers (n=2) were removed (*SMD*=0.26; *95%CI*=0.12–0.46; χ^2= 14.16; I^2=22% *p*=0.22). There were no *probably blinded* outliers. Nine trials included *most proximal* social skills outcomes (four parent and five teacher ratings). Four of these included a core specialised social skills training component. The effect was significant (*SMD*=0.47; *95%CI*=0.15–0.78) as was heterogeneity (χ^2=22.98; I^2=65%; *p*<0.01). Restricting the analysis to the no/low medication studies increased heterogeneity (N=5; χ^2=22.08; I^2=86%; *p*<0.01) so that while the effect size increased it was no longer significant (*SMD* = 0.67; 95%CI=-0.20–1.55). When outliers (n=1) were removed the effect remained (*SMD*=0.30; *95%CI*=0.07-0.52) and heterogeneity was non-significant (χ^2=4.04; I^2=0% *p*=0.54).

Academic achievement was measured in nine trials (six parent or teacher questionnaire-based measures and three objective assessments). Seven studies had a specialised component to specially target this aspect of impairment. *Most proximal* effects were significant and heterogeneity was non-significant (*SMD*=0.28; *95%CI*=0.06–0.50; χ^2 =14.55; I^2=45%; *p*=0.07) and persisted when outliers (N=2) were removed (*SMD*=0.16;

95%CI=0.01–0.31) and heterogeneity was non-significant (χ^2=7.95; I^2=37%; *p*=0.16). There were insufficient no/low medication studies to conduct a sensitivity analysis.

{figure 3}

There was no association between larger effect sizes and lower Jadad ratings. In fact, for *most proximal* ADHD (*t* = 2.52; p = 0.02), higher quality trials yielded larger effects. Meta-regression did reveal larger effect sizes in trials with younger children for *most proximal* positive parenting *(t=-2.63; p = 0.03) most proximal ADHD (t = -2.09; P = 0.05 and most proximal* conduct problems *(t = -2.46; P = 0.03).*

Discussion

The current meta-analyses found blinded evidence that behavioral interventions used to treat children and adolescents with ADHD had beneficial effects on important aspects of child and parent functioning. This contrasts with the lack of blinded evidence relating to ADHD symptoms reported in Sonuga-Barke et al.[19]. Specifically, in this analysis behavioral interventions improved parenting, reducing negative and increasing positive parenting, and reduced children's comorbid conduct problems.

Although improving parent functioning was rarely their primary therapeutic goal nearly all behavioral interventions included parent training as a core therapeutic mechanism. Positive effects on these outcomes are therefore both expectable and, in some ways, a necessary condition for subsequent impacts on children's behavior. Given the need to pool across very diverse and often rather general parenting assessments a fine-grained analysis of these effects was not possible. For instance, positive parenting analyses pooled studies with general assessments of overall increases in positive behaviours/strategies (e.g., praise, encouragement[61]) together with measures of their appropriate use[25] according to therapeutic models. This is important as, according to most models[28], simply increasing levels of positive parenting may not be sufficient to produce positive changes in children's behaviour. Objective effects on parenting were reflected in improved parenting self-concept - an empowering effect important in the process of breaking negative parent-child interaction

cycles[31]. Increased parenting confidence could come from working with experienced therapists who validate parents' approaches and/or implementing behavioral strategies and seeing their positive effects. It may also be an effect of psycho-education that emphasizes the power parents have to influence developmental outcomes[67.] Given these parenting-specific positive effects it was perhaps surprising that no beneficial effects were seen on parent mental health more generally. It would seem that the high levels of mental health problems that often affect parents of children with ADHD are not solely the result of issues around parenting morale but rather reflect a more deep-seated, pervasive psychological aspect perhaps reflecting shared genetic risk for mental health problems within families[68, 69]. There was also blinded evidence that behavioral interventions reduced conduct problems in children with ADHD; benefits of behavioral interventions for children seen with conduct disorder extend to those with a full ADHD diagnosis[25]. Given the limited number of studies with *probably blinded* measures and the fact that few had objective measures of child behavior measured at both home and school we were unable to assess the generalisation of child effects across settings. According to *most proximal* measures children's academic performance and social skills were also improved – an effect that is perhaps not surprising as trials included in these analyses often specifically targeted these aspects of impairment with specialised packages. If these effects could be corroborated with blinded ratings this would be encouraging given the inconsistent evidence regarding the effects of medication on these outcomes[44, **55**].

When interpreting the current analysis, it is important to take a number of factors into account; all meta-analyses are constrained by the quality and diversity of the studies available for inclusion. First, for nearly all of the analyses there was significant SMD heterogeneity between studies that may reflect the variety of intervention and outcome types analysed. In most, though not all cases, removing outliers identified using funnel plots reduced this heterogeneity while leaving treatment effects significant. Second, we could not establish how many parents had definite parenting or mental health problems, or how many children had clinical levels of conduct problems. As participants were specifically selected for

ADHD in childhood, it is likely that substantial numbers of individuals were unaffected by these additional problems. As a consequence effect sizes seen for these outcomes, given the smaller room for improvement, are likely to be an under-estimate of the true effects of behavioral interventions. Third, Sonuga-Barke et al[19] raised questions about the status of the *probably blinded* measures as valid outcomes. This is because they were often based on relatively small snap-shots of behavior or a rating by a teacher who may not know the child well. However, in the current study these measures proved to be sensitive to treatment-related change. Fourth, our evaluation did not explore the impact on long-term outcomes where one might predict a more robust impact of behavioral interventions. Fifth, while we established that parenting improved on rather artificial trial-based assessments these may not have been able to capture improvements in everyday life situations. Sixth, there were insufficient studies to explore whether interventions specifically tailored for ADHD[64] were more effective than parenting interventions designed to treat more general childhood behaviour problems or other aspects of impairment (social and academic skills). Seventh, the pool of trials meeting inclusion criteria was dominated by parenting interventions. This meant that our analysis says little specifically about the value of child- or teacher-focused interventions. Eighth, in a related manner no trials included measures of changes in adult responses to children with ADHD other than parents. Finally, we decided not to conduct or report an analysis of publication bias using techniques such as funnel plots because their interpretation is equivocal when based on a small number of studies – with difficulty in particular distinguishing between the effects of study heterogeneity and publication bias with sparse data [36].

In summary, while more evidence is required before behavioral interventions can be supported as a front-line treatment for core ADHD symptoms, we found evidence that they do have beneficial effects on parenting and parents' sense of empowerment as well as independently corroborated effects on conduct problems in children with ADHD. Initial evidence from *proximal outcomes* relating to academic achievement and social skills needs

to be confirmed by *probably blinded* analyses and greater exploration is needed on the moderating impact of child age on intervention outcome.

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Table 1: Characteristics of included studies.

Trial	Treatment		Control	Jadad rating	Sample size		Age range	Sex	Medicated For ADHD
	Delivery	Type			T	C	years	% male	%
Abikoff (2012) [34]	parent & teacher	behavioral training	wait list	2	61	33	8 - 11	69	36
Antshel (2003)[43]	child & parent	social skills training	wait list	2	80	40	8 - 12	75	93
Bloomquist (1991)[44]	child, parent & teacher	cbt	wait list	2	20	16	8.58 mean	69	0 in analysis
Bor (2002) [24]	parent	behavioral training	wait list	3	26	37	3.6 mean)	73	0
Brown (1986) [45]	child	self-control training	attention control	2	10	8	5–13	85	0
Chacko (2009)[46]	parent	behavioral training	wait list	2	40	40	5-12	73	38.75
Evans (2011) [47]	parent & child	behavioral and social skills training	tau	1	31	18	11-13	71	57
Fabiano (2010)[48]	children	daily report card	tau	2	33	30	6-12	86	52
Fabiano (2012) [49]	parent	behavioral training	wait list	2	27	28	6 -12	87	54
Fehlings (1991) [50]	parent & child	cbt	Attention control	2	13	13	8-11	100	0
Hoath (2002) [51]	parent	behavioral training	wait list	1	9	11	5-9	76	70
Horn (1991) [52]	parent & child	behavioral & self-control training	placebo	2	16	16	7-11	no info	0
Jones (2008) [53]	parent	behavioral training	wait list	3	50	29	3.8 mean	68	0
Kapalka (2005) [54]	parent	behavioral training	wait list	0	45	41	5 - 10	100	no info
Langberg (2008)[55]	child & parent	organizational skills training	wait list	1	24	13	Grade 4 - 7	83	43
Langberg (2012)[35]	child & parent	organizational skills training	wait list	2	23	24	Grade 6 - 8	74	66
Mikami (2011)[56]	parent	parent coaching on social skills	wait list	2	32	30	6-10	68	64.5
Molina (2008) [57]	child & parent	organizational skills training	community	2	11	9	Grade 6 - 8	75	31
MTA (1999;2000 ;2006). [40, 41, 42]	child, parent & teacher	multi-component home, school and camp	tau	4	144	146	8.33 mean	80	47
Pfiffner (1997)[33]	child & parent	behavioral training & cbt	wait list	2	9	9	8 - 10	72	44
Pfiffner (2007)[58]	child & parent	behavioral training & cbt	wait list	2	36	33	7 - 11	66	3
Pisterman (1989) [59]	parent	behavioral training	wait list	3	23	23	4.1 mean	80	11
Pisterman (1992) [60]	parent	behavioral training	wait list	3	23	22	4.1 mean	91	9

Power (2012) [61]	child, & parent,	behavioral & academic skills training	attention	2	100	99	Grade 2 - 6	68	43
Sonuga-Barke (2001) [62]	parent	behavioral training	counseling	3	30	28	2–4	62	0
Sonuga-Barke (2004) [63]	parent	behavioral training	wait list	2	59	30	2-4	no info	0
Thompson (2009) [64]	parent	behavioral training	wait list	4	21	20	2–6	73	0
Tracey (2005) [65]	parent	stress mangement	wait list	2	20	20	6 - 15	88	88
V d Hoofdakker (2007) [66]	parent	behavioral training	tau	2	48	48	4-12	76	40
Webster-Stratton (2011) [25]	parent & child	behavioral training	wait list	3	49	50	6.4 mean	75	13

Notes : cbt = Cognitive behavioral therapy ; tau = treatment as usual ; no info = no information provided in the paper ; grade = school year.

Table 2: Measures used in each trial for the different outcomes

		CHILD				PARENT			
		ADHD	CP	SS	AS	MH	SC	PP	NP
Abikoff [34]	MPROX				APRS[1-P]				COSS[2-P]
	PBLIND								
Antshel [43]	MPROX			SSRS[3-P]					
	PBLIND								
Bloomquist[41]	MPROX	CTRS[4-T]		SSCSA[5-P]					
	PBLIND								
Bor[24]	MPROX	ECBI[6-P]	ECBI[6-P]			DASS[7-P]	PSOC[8-P]		PS[9-P]
	PBLIND		FOSR[10-OBS]						FOSR[10-OBS]
Brown[45]	MPROX	CPRS[11=P]	ACTeRS[12-T]	ACTeRS 12-T	WRAT[13-TEST]				
	PBLIND	ACRS[14-T]							
Chacko[46]	MPROX	DBD [15-P]	DBD [15-P]	IRS [16-P]		BDI[17-P]		DPICS[18 OBS]	DPICS 18OBS
	PBLIND							DPICS 18 OBS	DPICS[18 OBS]
Evans[47]	MPROX	ADHDRS[19-P]		IRS[16-T]	IRS[16-T]				
	PBLIND								
Fabiano [48]	MPROX	DBD[15-T]	DBD[15-T]		APRS[1-P]				
	PBLIND								
Fabiano[49]	MPROX		ECBI[6-P]					DPICS[18-OBS]	DPICS[18-OBS]
	PBLIND							DPICS[18-OBS]	DPICS[18-OBS]
Fehlings[450]	MPROX	WWAS[20-P]							
	PBLIND								
Hoath[51]	MPROX	CAPS[21-P]	ECBI[6-P]			DASS[7-P]	PSBC[22-P]		PS[9-P]
	PBLIND	CAPS[21-T]	SESBI[23-T]						
Horn[452]	MPROX	CPRS[11-P]							
	PBLIND								
Jones[53]	MPROX	CPRS[11-P]							
	PBLIND								
Kapalka[54]	MPROX		SSQ [24-T]						
	PBLIND								
Langberg[55]	MPROX				APRS[1-P]				
	PBLIND								
Langberg[35]	MPROX	VADPRS[25-P]			HPC[26-P]				COSS[2-P]
	PBLIND								
Mikami [56]	MPROX			SSRS[3-P]				PBIPC [27 obs]	PBIPC [27 obs]

	PBLIND							PBIPC[27] obs	PBIPC[27] obs
Molina[57]	MPROX		ACPS[28P]		Sch grad[29]				
	PBLIND								
MTA[40,41,42]	MPROX	SNAP[30-P]	SNAP[30-P]		WIAT[31-] test	BDI[17-P]		PCRQ[32-] P	PCRQ[32-P]
	PBLIND	Classob[33-] OBS	Classob[33-] OBS					OBS[34]	
Pfiffner[33]	MPROX			SSRS[3-P]					
	PBLIND								
Pfiffner[58]	MPROX			SSRS[3-P]					
	PBLIND								
Pisterman[59]	MPROX		clinob[35-] OBS					clinob[35-] OBS	clinob[35-] OBS
	PBLIND		clinob[35-OBS]					clinob[35-] OBS	clinob[35-] OBS
Pisterman[60]	MPROX	clinob[35-OBS]	clinob[35-OBS]					clinob[35-] OBS	clinob[35-] OBS
	PBLIND	clinob[35-OBS]	clinob[35-OBS]					clinob[35-] OBS	clinob[35-] OBS
Power[61]	MPROX	SNAP[30-P]	SNAP[30-P]		APRS[1-T]		PES[36-P]	PCRQ[32-] P	PCRQ[32-P]
	PBLIND								
Sonuga-Barke [62]	MPROX	PACS[37-P]	PACS[37-P]			GHQ[38-P]	PSOC[8-P]		
	PBLIND	homeob[39-] obs							
Sonuga-Barke [63]	MPROX	PACS[37]				GHQ[38-P]	PSOC[8-P]		
	PBLIND								
Thompson[64]	MPROX	PACS[37]	PACS[37]			GHQ[38-P]		GIPCI[40-] OBS	EE[39-] SPEECH
	PBLIND	homeob[39-] OBS	GIPCI[40-] OBS					GIPCI[40-] OBS	EE[39-] SPEECH
Tracey[65]	MPROX					BDI[17-P]	PLOC[42-] P		PS[9-P]
	PBLIND								
Van den Hoofdakkar[66]	MPROX	CPRS[11-P]				PSI[43-p]	PSI[43-p]		
	PBLIND								
Webster-Stratton [25]	MPROX	CPRS[11-P]	CPRS[11-P]	SCS[44-P]				PPI [45-P]	PPI[43-P]
	PBLIND	COCA-R[46]						DPICS[18-] OBS	DPICS[17-] OBS

Note: MPROX=most proximal rating; PBLIND=probably blinded rating. ADHD Attention Deficit Hyperactivity Disorder,; CP conduct problems; SS social skills; AS academic skills; MH mental health; SC self concept; PP positive parenting; NP negative parenting; Superscript letter codes who provided the assessment. [P]=parent; [T]=teacher; [OBS]=observation; [SPEECH]=speech

sample; [TEST]=academic skills test. Superscript number gives full name of test; [1] Academic Performance Rating Scale [2] Children's Organizational Skills Scale [3] Social Skills Rating Scale [4] Conners Teachers Rating Scale [5] Walker-McConnel Scale of Social Competence and School Adjustment [6] Eyberg Child Behavior Inventory [7] Depression Anxiety and Stress Scale [8] Parenting Sense of Competence Scale [9] Parenting Scale [10] Family Observation Schedule [11] Conners Parent Rating Scale – Hyperactivity [12] ACTeRS ADD-H Comprehensive Teachers Rating Scale [13] Wide Range Achievement Test [14]Abbreviated Conners Rating Scale [15] Disruptive Disorders Rating Scale [16] Impairment Rating Scale [17] Beck Depression Inventory [18] Dyadic Parent-child Interaction Coding System [19] Attention Deficit Hyperactivity Disorder Rating Scale[20] Werry Weiss Activity Scale [21] Child Attention Problem Rating Scale [22] Problem Setting and Behavior Checklist [23] Sutter-Eyberg Student Behavior Inventory Revised. [24] Social Situations Questionnaire [24] APRS [25] Vanderbilt ADHD Diagnostic Parent Rating Scale [26] Homework Problem Checklist [27] Parental Behavior in Parent-Child Interaction. [28] Aggression and Conduct Problem Scale [29]School Grade Records [30] Pelham Swanson and Nolan Questionnaire [31] Wechsler Individual Achievement Test [32] Parent Child Relationship Questionnaire [33] Classroom Observation [34] Observed constructive parenting [35]Clinic Observation [36] Parent as Educator [37] Parent Account of Childhood Symptoms Interview [38] General Health Questionnaire [39] Home observation of on task behaviour [40] Global Impressions of Parent Child Interaction Revised [41] Expressed Emotion measured using the Pre-school Five Minute Speech Sample [42] Parents Locus of Control [43] Parenting Stress Inventory [44] Social Competence Scale [45] Parenting Practices Inventory. [46] Coder Observation of Classroom Adaption-Revised: Cognitive Concentration.

List of Figure Headings

Figure 1: Flow chart showing the selection of trials. See supplementary information for specific reasons for exclusion

Figure 2: Parental outcomes

Figure 2: Child outcomes

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✓**Financial and Material Support.** All sources of grant or other financial support, as well as any material support, are listed in the appropriate sections of this manuscript. If no funding was received, please state this.

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Manuscript Title: The impact of behavioral interventions for children and adolescents with attention-deficit hyperactivity disorder: A meta-analysis of randomised controlled trials across multiple outcome domains

Complete Author List (in order): David Daley , Saskia van der Oord, Maite Ferrin, Marina Danckaerts, Manfred Doepfner, Samuele Cortese, & Edmund JS Sonuga-Barke on behalf of the European ADHD Guidelines Group

Corresponding Author Name: Edmund J.S. Sonuga-Barke and David Daley

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Behavioral interventions in attention deficit / hyperactivity disorder: A meta-analysis of randomized controlled trials across multiple outcome domains

David Daley, PhD, Saskia van der Oord, PhD, Maite Ferrin, MD, PhD, Marina Danckaerts, MD, PhD, Manfred Doepfner, PhD, Samuele Cortese, MD, PhD, & Edmund JS Sonuga-Barke, PhD, on behalf of the European ADHD Guidelines Group

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We are also grateful for the support given by Jana de Vos, MSc and Stephanie Kristensen, MSc, KU Leuven, Belgium, and Jo Lockwood, BA, University of Nottingham, UK.

Funding

This work was not directly funded. However support for meetings was received from Brain Products GMBH, Janssen-Cilag, Eli Lilly & Co., Medice, Shire, and Vifor. No honoraria were received and funders made no input in the review and meta-analysis process or the writing of the manuscript.

Conflicts of Interest

Dr. Daley has provided educational talks for Eli Lilly & Co. and Shire; has attended an advisory board for Eli Lilly & Co.; has received support for educational travel from Eli Lilly & Co., Shire, and HP Pharma; and currently holds funding from Shire.

Dr. van der Oord has been involved in the development, implementation and trialing of 1) “Braingame Brian”, executive functioning game training for children with ADHD, and 2) “Zelf Plannen” a cognitive behavioral planning intervention for adolescents with ADHD. She has no financial interests in any of these interventions. Further, she has been a paid consultant for Janssen Pharmaceuticals, for the development and evaluation of a serious game “HealSeeker”, which is aimed at training cognitive functions.

Dr. Ferrin is a grant recipient for travel expenses from the Alicia Koplowitz Fundation, Instituto de Salud Carlos III (ETS 07/90902, BAE 09/90088), and Gobierno de Navarra (Beca Jeronimo de Ayanz 2011/12). She declares no other conflict of interest.

Dr. Danckaerts has served on the speaker’s bench of Janssen-Cilag, Eli Lilly & Co., Shire, Novartis, and Medice, and has received funding for clinical trials from Eli Lilly & Co. and Shire. Dr. Danckaerts has been involved in the development and dissemination of an ADHD-Toolkit for

teachers in primary school, distributed to all primary schools in Belgium by the Minister of Education and has been a consultant for Janssen Pharmaceuticals for the development and evaluation of a serious game “HealSeeker,” which is aimed at training cognitive functions.

Dr. Döpfner has received research support, served on advisory boards, and/or served as a speaker for Janssen-Cilag, Medice, Vifor, Shire, Eli Lilly & Co., and Novartis. Dr. Döpfner has been involved in the development, evaluation and dissemination of the German Therapieprogramm für Kinder mit hyperkinetischem und oppositionellem Problemverhalten (THOP) and Präventionsprogramm für Expansives Problemverhalten (PEP), which are behavioral interventions for children with ADHD. He is also head, supervisor, and lecturer at the School of Child Behavior Therapy at the University of Cologne. He has received royalties for treatment manuals (Beltz, Hogrefe Publisher) and as supervisor, lecturer, and consultant of the German Kassenärztliche Bundesvereinigung for the evaluation of behavior therapy. He is conducting an on-going trial on the effects of Omega-3/6 fatty acids supported by Vifor Pharma, and several trials on the effects of behavioral interventions for children with ADHD supported by the German Research Foundation, German Ministry of Education and Research, Shire, and Eli Lilly & Co.

Dr. Cortese reports no biomedical financial interests or potential conflicts of interest.

Dr. Sonuga-Barke has been involved in the development, implementation, and trialing of the New Forest Parenting Programme for preschool children with ADHD and has received royalties from sales of a New Forest Parent Training self-help manual. He has served on the speaker’s board of Shire, UCB Pharma, Janssen Cilag, and Medice. He has served as a consultant to UCB Pharma and Shire. He has received research support from Shire. He has served on advisory boards of Shire, Flynn Pharma, and AstraZeneca. He has received conference support from Shire.

Figure 1

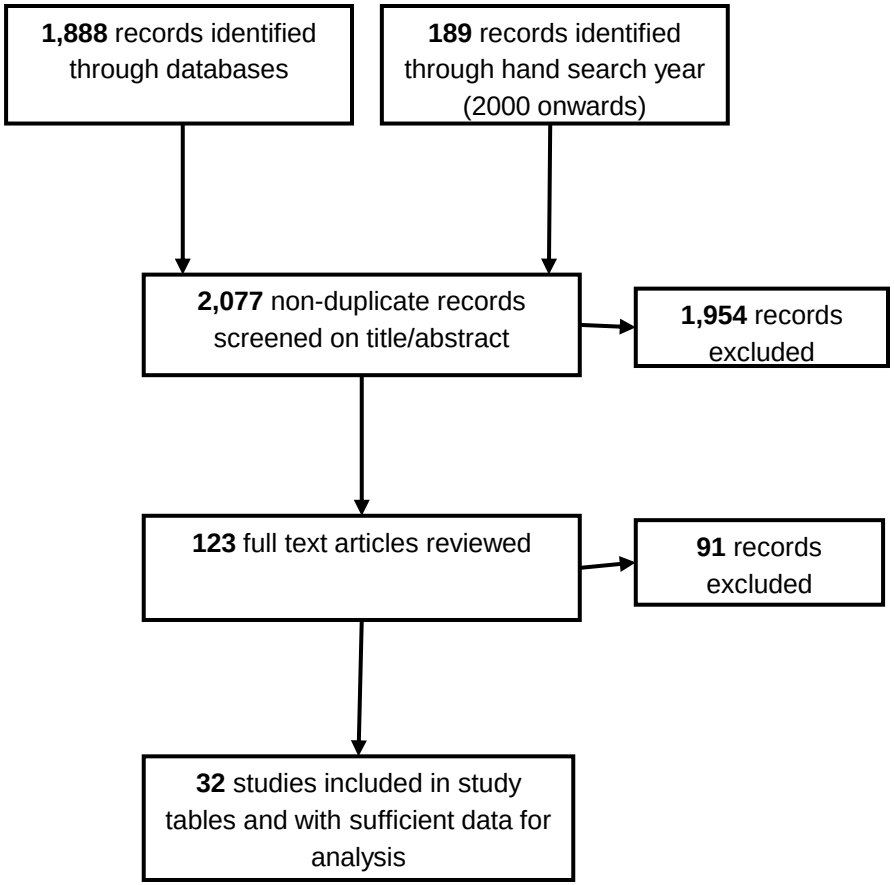
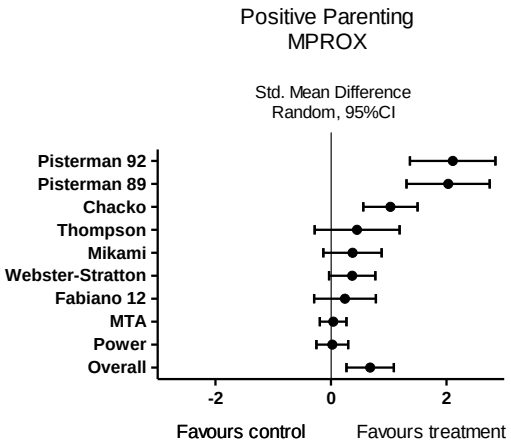
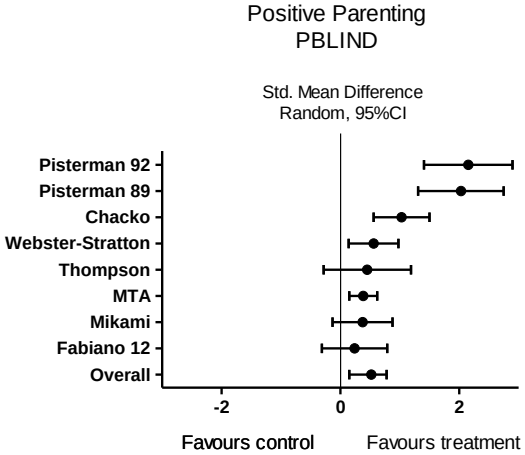

1,888 records identified through databases
189 records identified through hand search year (2000 onwards)
2,077 non-duplicate records screened on title/abstract
1,954 records excluded
123 full text articles reviewed
91 records excluded
32 studies included in study tables and with sufficient data for analysis

Figure 2



Overall SMD=0.68:95%CI=0.27-1.09



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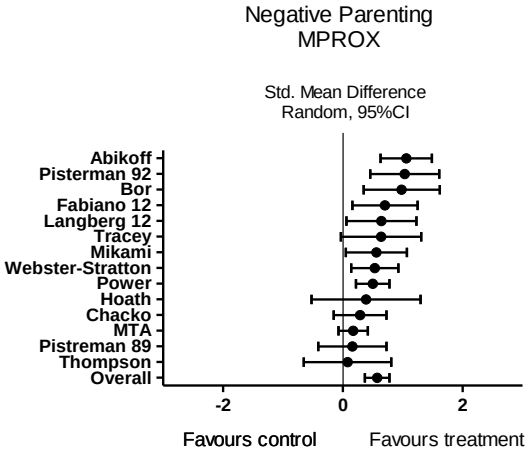
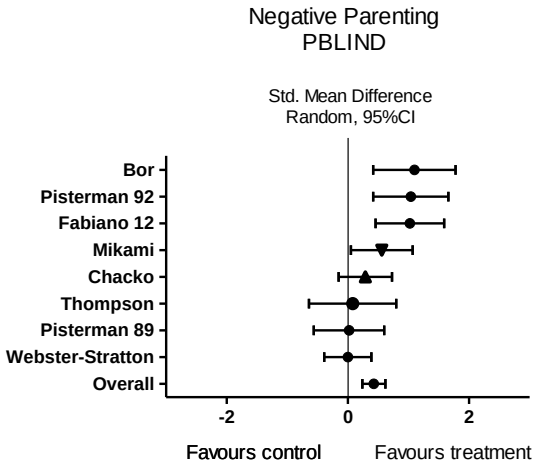
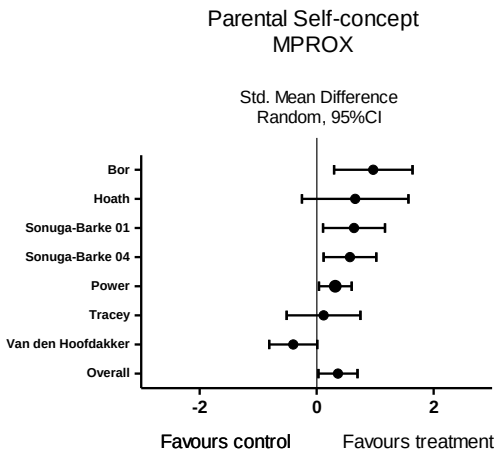


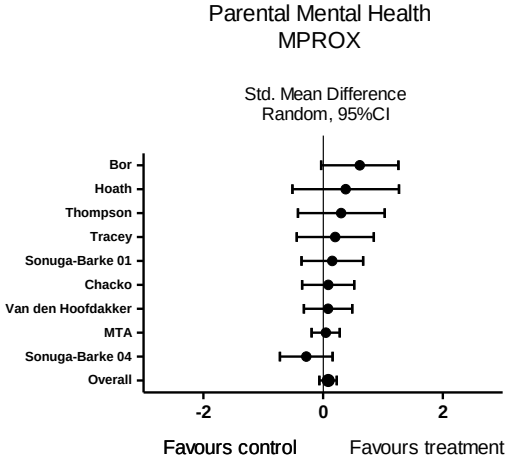
overall SMD=0.57;95%CI=0/37-0.78



Overall SMD=0.43:95%CI=0.24-0.62

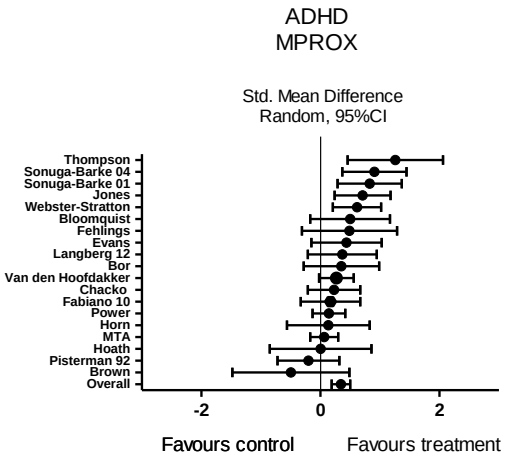


Overall SMD=0.37;95%CI=0.03-0.70

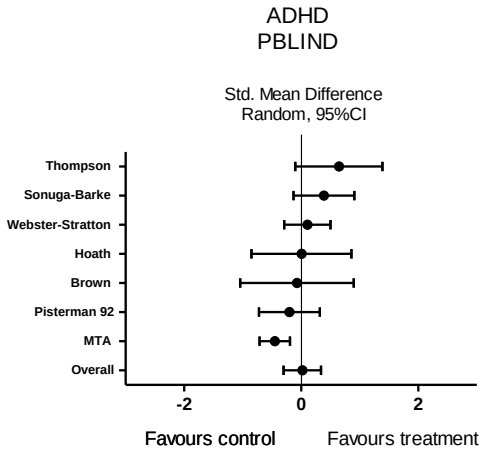


Overall SMS=0.09:95%CI=0.06-0.23

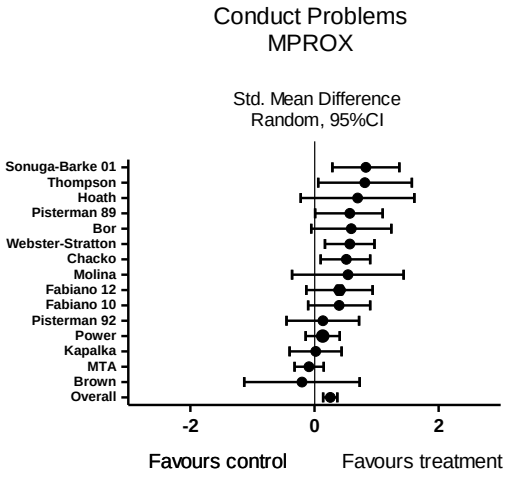
Figure 3



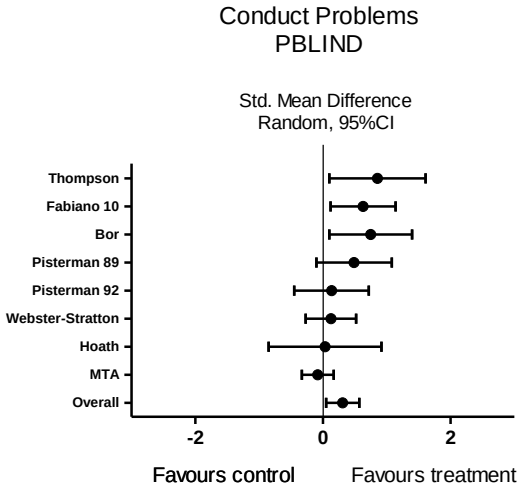
Overall SMD=0.35; 95%CI=0.19–0.50



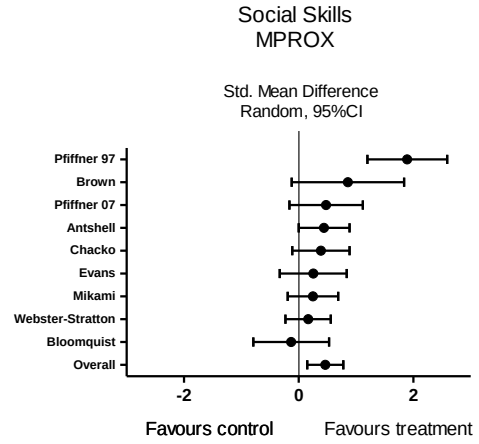
Overall SMD=0.0.02;95%CI=-0.30-0.34



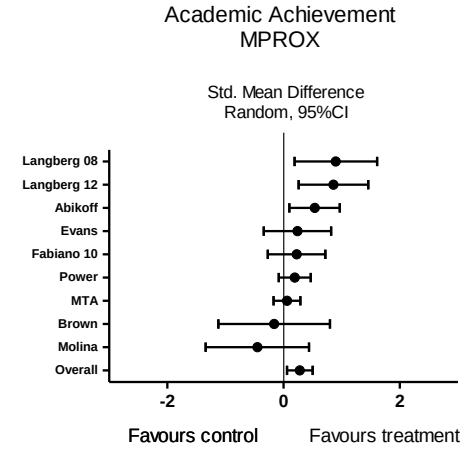
Overall SMD=0.26;(%%CI=0.14-0.37



Overall *SMD*=0.31; *95%CI*=0.05–0.57



Overall *SMD*=0.47;95%CI=0.15-0.78



Overall *SMD*=0.0.28; 95%CI=0.06-0.59

1

Supplementary Material– excluded studies information

Study	Reasons for exclusion
Abikoff (1985)[1]	Not a behavioral intervention study explores Cognitive Training
Abikoff (2004)[2]	No appropriate control group behavioral intervention adjunctive to medication
Abikoff (2004a)[3]	No appropriate control group behavioural intervention adjunctive to medication
Altemeier (1997)[4]	Not randomized
Anastopolos (1993)[5]	Not randomized
Arnold (2003)[6]	MTA study that did not add any additional outcomes to our included studies
Barkley (1992)[7]	No appropriate control group this study is a comparison of three active therapies
Barkley (1996) [8]	Reports violation of randomization
Barkley (2000)[9]	Reports violation of randomization in 8 children
Barkley (2001)[10]	No appropriate control group this study compares three different combinations of intervention but does not have a control condition
Carlson (1992)[11]	Not randomized
Chacko (2003)[12]	Not a behavioral intervention this is a medication study
Christensen (1973)[13]	Not randomized
Christensen (1975)[14]	No appropriate control group this is a within subject design
Cohen (1981)[15]	Not randomized
Cunningham (1995)[16]	Not a specific ADHD sample
Doepfner (2004)[17]	No appropriate control group this study applies an addaptive and individually tailored approach to treatment
Dubey (1983)[18]	Randomization unclear. Groups were assigned, so that age and gender was evenly distributed.
Epstein (2007)[19]	Not a behavioral intervention
Evans (2005)[20]	Not randomized
Fabiano (2009)[21]	No appropriate control group this study is a comparsion of two behavioral interventions
Firestone (1981)[22]	No control group
Firestone (1986)[23]	No control group and Follow-up of a previously excluded study
Frankel (1997)[24]	Children with and without ADHD included in the sample
Gerber-von Muller (2009)[25]	No appropriate treatment control group
Gonzalez (2002)[26]	ADHD status of children unclear
Hanisch (2010)[27]	Not a specific ADHD sample
Hantson (2012)[28]	Not randomized

Hechtman (2004a)[29]	No appropriate control group behavioural intervention adjunctive to medication
Hechtman (2004b)[30]	No appropriate control group behavioural intervention adjunctive to medication
Hinshaw (1984a)[31]	No appropriate control group behavioural intervention adjunctive to medication
Hinshaw (1984b)[32]	No appropriate control group behavioural intervention adjunctive to medication
Hinshaw (2000)[33]	MTA study that did not add any additional outcomes
Horn (1987)[34]	No appropriate control group this study is a comparison of two behavioral interventions
Horn (1990)[35]	No appropriate control group this study is a comparison of two behavioral interventions
Hupp (2002)[36]	Case study
Iolango (1993)[37]	Same dataset as Horn et al 1990 which as been excluded
Jensen (2001)[38]	MTA study that did not add any additional outcomes
Jensen (2004)[39]	MTA study that did not add any additional outcomes
Jensen (2007)[40]	MTA study that did not add any additional outcomes
Kapalka (2004)[41]	Not a behavioral intervention
Kapalka (2005)[42]	weak randomisation procedure
Kern (2007)[43]	No appropriate control group this study is a comparison of two behavioral interventions
Kienle (2009)[44]	Not randomized
Klein (1997)[45]	No appropriate control group this study explores combinations of medication and behavioural intervention
Klein (2004)[46]	Methodology paper on design of study of Hechtman 2004 No control group
Lerner (2011)[47]	Randomization unclear
Lloyd (2010)[48]	Not a behavioral intervention
McGrath (2011)[49]	Study met criteria for inclusion but data not amenable to analysis and authors were unable to provide the data.
McNeil (1991)[50]	Randomization unclear
Meyer (2007).[51]	No appropriate control this study compares parent versus self-monitoring for homework problems
Mikami (2013)[52]	No appropriate control this study compares two behavioral interventions
Miranda (2002)[53]	Randomization unclear
Odom (1996)[54]	Randomization unclear
Osterberg (2012)[55]	Randomization unclear Not an entirely ADHD sample
O'Leary (1976)[56]	Insufficient detail in summary statistics to allow calculation of SMD .
Papazian (2009)[57]	Not a behavioral intervention

Pariseau (2010)[58]	No appropriate control group this is a within subject design
Pelham (1977)[59]	Case-study
Pelham (1993)[60]	No appropriate control group this is a within subject design
Pelham (1999a)[61]	Review paper, no data
Pelham (1999b)[62]	Review paper, no data
Pelham (2000)[63]	No control group Same sample as MTA comparing The Behavioral and combined group
Pfeiffer (2008)[64]	Not a specific ADHD sample and not a behavioral intervention
Pfeiffer (2007)[65]	Not fully randomized
Poulsen (2010)[66]	Not fully randomized
Presentacion (2010)[67]	Not randomized
Rapport (1982)[68]	Case study (two)
Rieppi (2002)[69]	MTA study that did not add any additional outcomes
Rosen (1984)[70]	Not randomized
Rutter (2000)[71]	Review paper, no data
Sanders (2007)[72]	Not a specific ADHD sample
Sayal (2010)[73]	Not a behavioral intervention
Schafto (1977)[74]	Case-study
Schumann (1998)[75]	Not a specific ADHD sample
Scott (2010)[76]	Not a specific ADHD sample
Shaffer (2001)[77]	Not a behavioral intervention
So (2008)[78]	No appropriate control group behavioral intervention adjunctive to medication
Springer (2010)[79]	Not randomised
Strayhorn (1989)[80]	Not a specific ADHD sample
Strayhorn (2002)[81]	No appropriate control group comparinson of two behavioral approaches
Storebo (2012)[82]	Behavioral intervention adjunctive to medication
Swanson (2001)[83]	Reanalysis of MTA study no new outcomes added
Thorell (2009)[84]	Not adequately randomized, allocation to condition influenced by other factors
Thurston (1979)[85]	Randomization unclear
Tutty (2003)[86]	No appropriate control group behavioral intervention adjunctive to medication
Van der Oord (2007)[87]	No appropriate control group behavioral intervention adjunctive to medication
Waxmonsky (2008)[88]	No appropriate control group behavioral intervention adjunctive to medication
Waxmonsky	No appropriate control group behavioral intervention adjunctive to

(2010)[89]	medication
Wolraich (1978)[90]	No appropriate control group
Wulbert (1977)[91]	Case-study

Supplementary references

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