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Research Review: The most effective parenting program content for disruptive child behavior – a network meta-analysis

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Background: Programs to support parents are the recommended strategy to reduce disruptive child behavior problems. Efforts have been made to demonstrate which program components (i.e., clusters of techniques taught) increase program effects, but these methods fail to account for the fact that components rarely operate in isolation. We examine how combinations of components cluster together to form program types and use network meta-analysis to estimate the relative effects of these program types. **Methods:** We updated an existing systematic review of parenting programs for disruptive child behavior and identified 197 randomized trials. We modeled clusters of components in each trial arm and chose the best-fitting model. We subsequently took 20 draws from the probability distribution of the latent class for each arm, entered each draw into a network meta-analysis model and combined findings using Rubin's rules. Combined estimates were bootstrapped to rank the clusters. We estimated main models and separate models for prevention and treatment settings. **Results:** A five-class solution fit the data best: (1) behavior management; (2) behavior management with parental self-management; (3) behavior management with psychoeducation and relationship enhancement; (4) maximal component loading and (5) no/minimal component loading (i.e. control). In the main model and in treatment settings, all four program types were effective compared to no/minimal components. In prevention settings, only behavior management and behavior management with parental self-management were effective compared to no/minimal components. Probabilistic ranking showed that overall and in treatment settings, behavior management had the largest chance, and in prevention settings, behavior management with self-management had the largest chance, of being most effective compared to no/minimal components. **Conclusions:** Programs with more focused content seem more likely to yield stronger effects, and different foci may be needed in treatment versus prevention settings. Next steps include identifying individual family differences in optimal program content. **Keywords:** Parenting program; disruptive child behavior; effective components; systematic review; network meta-analysis.

Introduction

Few programs in child psychology and psychiatry are as extensively studied as parenting programs for children's disruptive behavior problems (Weisz & Kazdin, 2017). Disruptive child behavior includes an angry or irritable mood, oppositional behavior, and vindictiveness (American Psychiatric Association, 2013). Disruptive behavior originates from an interplay between child and environmental characteristics (Fairchild et al., 2019), with parenting playing a key role in maintaining and amplifying disruptive behavior (Patterson, 1982). Parenting programs are therefore the recommended strategy to prevent and treat disruptive child behavior (e.g. NICE guidelines; Pilling, Gould, Whittington, Taylor, & Scott, 2013).

The second half of the past century laid the theoretical and empirical foundation for today's programs, most notably, Patterson's theory on coercive parent–child interactions (Patterson, 1982) and the first randomized evaluations of parenting programs for disruptive child behavior (e.g. Bernal, Klinnert, & Schultz, 1980; Peed, Roberts, & Forehand, 1977). The first decades of the present century replicated the efficacy and effectiveness of these programs and summarized this evidence in dozens of systematic reviews and meta-analyses (e.g. Leijten et al., 2019; Lundahl, Risser, & Lovejoy, 2006; Weisz et al., 2017). More recent evaluations have experimented with different delivery formats (e.g. Thongseiratch, Leijten, & Melendez-Torres, 2020) and target populations (e.g. Lessard, Normandeau, & Robaey, 2016; Mersky, Topitzes, Grant-Savela, Brondino, & McNeil, 2016).

Unlike some other fields (e.g. cognitive behavior therapy for depression and exposure therapy for anxiety), the field of parenting programs for disruptive child behavior is dominated by 'branded' programs that are often known by their name (e.g. Helping the Noncompliant Child; Incredible Years; Parent–Child Interaction Therapy; Parent-Management Training—Oregon; Triple P Positive Parenting Program) rather than their content. Most established programs teach parent's behavior management techniques derived from operant and social learning theory to break coercive parent–child interaction cycles that maintain and ameliorate children's disruptive behavior (Kaehler, Jacobs, & Jones,

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2016). Programs differ in additional content they may offer. Some add parental self-management (e.g. problem solving and stress relief; Sanders et al., 2004), psychoeducation (e.g. Abikoff et al., 2015), parent–child relationship enhancement techniques (e.g. Zisser, Herschell, & Eyberg, 2017) or helping parenting cultivate social and emotion regulation skills in their children (e.g. Webster-Stratton & Reid, 2017).

To help the field move beyond the dominance of branded programs and identify the key changes in parent–child interactions that are essential for reducing disruptive child behavior, efforts have been made to shed light on the program content that contributes to program effectiveness. These efforts include meta-regressions of individual program components (i.e. clusters of parenting techniques taught) associated with program effects (Kaminski, Valle, Filene, & Boyle, 2008; Leijten et al., 2018, 2019) and head-to-head trials comparing two or more versions of the same program (e.g. Sanders, Markie-Dadds, Tully, & Bor, 2000) or different programs (e.g. Sonuga-Barke et al., 2018). Although these are valuable strategies, components rarely exist or operate in isolation and head-to-head trials of different brands mask which components are actually being compared.

One way to address this problem is to cut across branded programs by grouping programs by what can be described as 'clinically meaningful units', or clusters of components that collectively define a coherent approach to an intervention (Melendez-Torres, Bonell, & Thomas, 2015). However, the question of what these clinically meaningful units might be, if they are not 'brands', remains a developing one. A common strategy is to test whether components account for statistical heterogeneity in a series of single-predictor meta-regressions, but the number of components can 'overwhelm' the number of trials such that a multipredictor meta-regression is impossible. In addition, single-component meta-regressions cannot shed light on how combinations of components cluster and relate to effectiveness. Moreover, these meta-regressions are generally limited to active intervention versus control comparisons, meaning that all information from head-to-head trials is lost.

Network meta-analysis overcomes these limitations by identifying how components cluster together empirically across program brands and trials and relating these clusters of components to program effects. It rigorously integrates direct evidence (i.e. within-trial comparisons of different parenting programs) and indirect evidence (i.e. the 'implied' comparison of two interventions from separate within-trial comparisons, each testing one intervention against a common comparator). It does so by constructing networks of evidence from trials testing relevant comparators, where nodes in the network relate to clusters of program components and links between nodes represent direct evidence comparing two clusters. Importantly, network meta-analysis allows for the comparison of clusters of program components that have not been directly compared (also known as 'indirect treatment comparison'). Statistical inference in network meta-analysis is led by estimating, as a set of basic parameters, the set of contrasts of each active cluster of program components against a reference category, generally a control condition that includes minimal or no components. Effect estimates from trials comparing two active clusters are then re-expressed as the difference between the two basic parameters. Analysis makes use of standard meta-regression based methods, though implementation has often been undertaken in a multivariate meta-analysis framework (White, 2011). A common feature of network meta-analysis is the use of bootstrap-based methods to rank interventions probabilistically. This means that rankings capture both magnitude and certainty of effect. Network meta-analysis remains an uncommonly used method in child psychology and psychiatry despite its widespread use in mental health and clinical effectiveness more broadly (Cortese, Tomlinson, & Cipriani, 2019).

Theoretical models underlying parenting programs suggest several combinations of components. For example, many established programs are based on the Hanf model where parents first learn relationship building skills and then behavior management based on the premise that strengthening the parent–child relationship amplifies the effects of behavior management (Hanf, 1969). More generally, there are theoretical reasons to assume that 'more is better' in parenting programs for disruptive child behavior. Because many different factors contribute to the development of disruptive child behavior (Fairchild et al., 2019), comprehensive programs that address multiple different risk factors for disruptive child behavior (e.g. coercive cycles, parent–child relationship quality, and marital quality) would plausibly be more successful at reducing disruptive child behavior than programs that address a more limited number of risk factors (e.g. coercive cycles specifically).

Empirically, however, there is little evidence for the assumption that including a more diverse set of components enhances program effects. Programs that provide additional components to basic parenting techniques tend to be less effective than programs that do not (Kaminski et al., 2008), especially in prevention settings (Leijten et al., 2019). In addition, from parenting programs to increase parental sensitivity in infants and young children, we know that 'lean' programs outperform longer programs with more components (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003). The present study aims to shed light on the optimal combination of program components to reduce disruptive child behavior.

In sum, this study sought to accomplish the following aims: (1) identify what combinations of components tend to naturally cluster in established parenting programs, opening up 'branded' programs to see how different programs are in terms of what they offer parents; (2) compare the relative effects of each cluster of components to identify whether some clusters more successfully reduce disruptive child behavior than other clusters and (3) rank these clusters in terms of their effects on disruptive child behavior. In doing so, we built on earlier work where we examined the role of individual program components (Leijten et al., 2018, 2019). The main findings from this earlier work were that few individual components seem to make a difference for program effects, and that if they do, they typically seem to make a difference only in either prevention or treatment settings. In the present study, we move beyond prior work on how single components predict outcomes and use network meta-analysis to examine how single components naturally cluster within programs and how these clusters compare in terms of program effects.

Methods

Search and study selection

We conducted our study in line with the PRISMA extension for reporting network meta-analysis (Hutton, Catala-Lopez, & Moher, 2015; see Table S1 for our checklist). We updated the systematic review of Leijten et al. (2019) and include trials published up to 2020 (PROSPERO protocol #CRD42019141844). We searched 11 databases (i.e. Database of Impact evaluations, ASSIA, Campbell Library, The Cochrane Library [Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials], EMBASE, ERIC, MEDLINE, National Criminal Justice Reference Service, The International Bibliography of the Social Sciences, PsycINFO, PILOTS) and 5 trial registries (ClinicalTrials.gov, Australian New Zealand Clinical Trials Registry, WHO International Clinical Trials Registry Platform, metaRegister of Controlled Trials). We included randomized trials of parenting programs based on social learning theory (i.e. redirecting children's behavior through differential reinforcement and modeling) that aimed to reduce disruptive child behavior problems in children aged 2–12. Trials arms that combined a parenting program with other interventions (e.g. a child program) were excluded. We did not preregister our analyses because they were secondary analyses of the original review and meta-analysis.

Data collection process and summary measures

We used a previously used coding scheme for scoring the presence versus absence of components in parenting programs for disruptive child behavior problems (Leijten et al., 2019; see Table S2). Coding was undertaken by one reviewer and checked by another. We coded programs as implemented in prevention settings if they adopted a universal prevention (i.e. targeting community samples) or selective prevention approach (i.e. targeting families at higher risk for disruptive child behavior) and as implemented in treatment settings if they adopted an indicated prevention (i.e. targeting families with emerging disruptive child behavior) or treatment approach (i.e. targeting families in outpatient clinics for children's mental health problems) because on the dimension of prevention to treatment, it is specifically between selective prevention and indicated prevention and treatment that program effects tend to significantly differ (Leijten et al., 2019).

We extracted all estimates of child disruptive behavior outcomes at the first post-treatment measurement and converted these using standard formulae into standardized mean differences (Cohen's *d*). Where multiple effect estimates for the same construct (i.e. disruptive child behavior) from the same treatment-control contrast were reported, we assumed that these were correlated with $r = .8$ and combined them to form a synthetic effect size (Borenstein, Hedges, Higgins, & Rothstein, 2011).

Risk of bias

Risk of bias of individual studies was assessed as high, low or unclear using the Cochrane Collaboration tool (Higgins et al., 2011). Based on Cochrane Handbook's standardized guidance, we rated trials on random sequence generation, allocation concealment, blinding of assessors, blinding of providers and families, incomplete outcome data, selective reporting and other sources of bias. A clear description of how random sequences were generated and whether allocation was concealed was often not reported in older trials. Participant blindness was not possible in any of the trials because parents actively participated in the programs. Bias on blinding of outcome assessors, addressing incomplete data and dropouts, and selective outcome reporting was typically limited or unknown.

Identifying program types based on component clusters (Aim 1)

We used trial arm as the unit of our analysis because some trials included multiple intervention arms. Subsequently, we estimated latent class models with intervention components as the manifest indicators and trial as a clustering design effect. The goal of this analysis was to understand the number of underlying parenting program types based on co-occurrence of their program components. We estimated sequential class models, starting with two classes, and chose an optimal solution on the basis of the Bayesian information criterion (BIC), adjusted BIC, Akaike information criterion (AIC), consistent AIC and scaled relative entropy, which was confirmed via a bootstrap likelihood ratio test. The result of this analysis was (a) a set of classes reflecting combinations of components tending to cluster together; (b) for each class, associated conditional probabilities that indicated how likely a component was to be present and (c) for each trial arm, a probability distribution indicating how likely the program implemented in that trial arm belongs to each of the classes.

Comparative effectiveness of program types (network meta-analysis; Aim 2)

We used network meta-analysis to relate the empirically derived program types (i.e. classes with different clusters of components) to program effectiveness. Because each trial arm carries its own probability distribution for each class, we needed to account for this measurement error. We did this by using pseudo-class imputations, a strategy frequently used to relate latent classes to distal outcomes (Wang, Hendricks Brown, & Bandeen-Roche, 2005); that is, an analytic situation such as this that includes both latent classes (program types based on component classes) and an outcome (program effectiveness) thought to be influenced by the latent class, but where a one-step model would be inappropriate because inclusion of the outcome would affect formation of the latent

classes (i.e. including program effectiveness in the first step of the model would affect formation of the program types). In pseudo-class imputations, a set of draws is taken from each observation's probability distribution. In each of the resultant imputed datasets, the relationship between the latent class and the outcome is estimated, and then estimates are combined using Rubin's rules. Other more modern methods for relating latent classes to distal outcomes, such as the application of misclassification matrices, are not applicable in this context as in this case the outcome, program effectiveness, is measured with error.

Consistent with standard practice, we undertook 20 pseudo-class imputations and estimated a random-effects network meta-analysis model in each of the 20 datasets. In the network meta-analysis, nodes were defined by component classes (i.e. program types). We estimated network meta-analyses in the frequentist paradigm using multivariate meta-analysis methods (White, 2011). We accounted for correlations between intervention-control comparisons in trials with more than two trial arms and assumed a common between-studies variance across all treatment comparisons in the network. This model was estimated once overall and again including a covariate indicating whether each trial was undertaken in a prevention or treatment context. The value of the meta-regression coefficient was allowed to vary over different intervention-control contrasts.

For each of the 20 datasets, we checked for connectedness of the evidence network and estimated design-by-treatment interaction tests as a global test of inconsistency, which is where direct and indirect evidence are in conflict (where the relative treatment effect estimated by B vs. C trials disagrees with the relative treatment effect for B vs. C implied by comparing A vs. B and A vs. C trials), combining χ^2 test statistics for each imputed dataset to estimate an overall significance test for inconsistency. We checked for transitivity by examining whether specific intervention classes were associated with differential patterns of participant or trial characteristics. Relative effect estimates from each of the 20 network meta-analyses were combined using Rubin's rules.

Probabilistic ranking of program types (Aim 3)

We ranked program types probabilistically by resampling 1000 times from the treatment effects and their precision in each of the 20 network meta-analyses and pooling the resulting repetitions. This yielded the probability that each program type (i.e. class reflecting a certain combination of components) would occupy each spot in a table ranking the most effective program types.

Results

Identifying program types based on component clusters (Aim 1)

Search and selection yielded 197 trials, including 430 trial arms, with extractable effect size data that entered our analysis (see Figure S1 and Table S3 for an overview of the included trials). Sequential estimation of latent class solutions suggested that while four-class and five-class solutions were reasonable, a five-class solution described the data best (Table 1). Consideration of the conditional probabilities of each component by class suggested that the four classes represented distinct parenting program types in addition to the fifth class, minimal/no components type that typically reflected the trials' control arms: (a) behavior management; (b) behavior management with parental self-management; (c) behavior management with psychoeducation and relationship enhancement; (d) maximal component loading (i.e. maximum number of components included).

Behavior management reflected differential reinforcement components to shape child behavior (e.g. praise and rewards, ignore and time-out). Parental self-management reflected components to support parents in their daily parenting role (e.g. problem-solving, emotion regulation, and marital support). Psychoeducation reflected components to inform parents about typical and atypical child development. Relationship enhancement reflected components to strengthen the parent–child relationship (e.g. child-led play and empathy). Maximal component loading typically included all of the components above and/or other additional components (e.g. guiding parents to teach their child emotional regulation or social skills). Classes and their conditional probabilities are described in Table 2. This solution yielded the lowest adjusted BIC while maintaining high-scaled relative entropy (97.5%). A bootstrap likelihood ratio test suggested that five classes were an improvement over four classes ($p < .05$), but that six classes did not represent a meaningful increment in fit ($p > .10$).

Comparative effectiveness of program types (Aim 2)

In the overall model, all active program types (i.e. programs based on each of the component combinations) were superior to no/minimal components. More important for this study's purposes, the program type with mainly behavior management was superior to the program type combining behavior management with psychoeducation and relationship enhancement (Table 3; Figure 1). The same pattern emerged for programs in treatment settings. For programs in prevention settings, only two out of four active program types were superior to no/minimal components: behavior management and combining behavior management with parental self-management. Also, in prevention settings, behavior

Table 1 Model fit indices suggesting a five-class solution described the data best

	2 Classes	3 Classes	4 Classes	5 Classes	6 Classes
BIC	3,089	2,279	2,159	2,165	2,242
aBIC	2,966	2,091	1,908	1,851	1,864
AIC	2,931	2,039	1,838	1,763	1,758
cAIC	3,128	2,338	2,238	2,264	2,361
Scaled relative entropy	98.7%	99.6%	98.5%	97.50%	97.6%

Table 2 Component prevalence in each latent class

					
Prevalence	26%	11%	7%	10%	46%
Psychoeducation on child development	8%	10%	72%	95%	1%
Psychoeducation on parent-child interaction development	13%	9%	80%	95%	5%
Reinforce positive child behavior using praise	99%	96%	89%	100%	3%
Reinforce positive child behavior using rewards	73%	67%	79%	100%	0%
Prevent reinforcement of disruptive child behavior using ignoring	86%	67%	54%	98%	0%
Prevent reinforcement of disruptive child behavior using time-out	92%	94%	92%	98%	2%
Prevent reinforcement of disruptive child behavior using negative consequences (e.g. removing privileges)	76%	75%	59%	100%	0%
Setting clear rules	46%	69%	80%	97%	0%
Monitoring	23%	22%	43%	0%	0%
Giving direct commands	81%	74%	74%	100%	0%
Parent-child play	32%	2%	83%	100%	0%
Parental empathy	0%	2%	33%	0%	0%
Parental self-management	0%	63%	43%	100%	0%
Marital support	0%	52%	19%	0%	0%
Parental problem solving skills	39%	92%	15%	100%	0%
Parental emotion regulation	0%	87%	54%	95%	1%
Teach parents to cultivate children's problem solving skills	3%	4%	26%	100%	0%
Teach parents to cultivate children's emotional regulation skills	3%	6%	24%	100%	0%
Teach parents to cultivate children's social skills.	4%	14%	0%	100%	0%

Add, Additional components to enhance general parent and child skills; BM, Behavior management; NONE, No or minimal components (typically control condition); PE, Psychoeducation; RE, Relationship enhancement; SM, Parental self-management.

management with parental self-management was superior to maximal component loading.

In other words, leaner program types that mainly included components that directly addressed disruptive child behavior, or that combined these components with parental self-management components, outperformed more extensive programs that combined behavior management with psychoeducation, relationship enhancement, and additional components. Although the exact pattern of superiority was slightly different for treatment and prevention settings, in both settings, leaner programs in several cases outperformed more extensive programs. Examination of design-by-treatment interaction tests did not reveal evidence of inconsistency (overall: $p = .33$; stratified: $p = .30$) nor was there clear evidence of intransitivity on the basis of trial of population characteristics. This suggests that estimates from direct and indirect evidence were not in conflict over the entire network; that is, the results of the network meta-analysis are reliable.

Probabilistic ranking of program types (Aim 3)

In line with the comparative effectiveness, there was a clear hierarchy in the overall literature of program types with the basic behavior management program type having the largest chance (87%) of being most effective compared to no/minimal components (Table 4). The same pattern emerged when examining treatment settings separately. In prevention, settings, however, numbers one and two switched places: the program type that combines behavior management with parental self-management had the largest chance (78%) of being most effective compared to no/minimal components and the basic behavior management program type came in second. In all models, program types combining behavior management with psychoeducation and relationship building and program types with maximal component loading had the smallest chances of being most effective compared to no/minimal components.

Discussion

We conducted a network meta-analysis to identify the optimal combination of parenting program components to reduce disruptive child behavior problems. We identified four active parenting program types: behavior management, behavior management with parental self-management, behavior management with psychoeducation and relationship enhancement, maximal component loading. All four types were effective compared to no/minimal components (i.e. control conditions). Behavior management programs had the largest chance to be most effective overall and in treatment settings; behavior management with parental self-management

Table 3 Comparative effectiveness of program types, expressed as Cohen's *d* (95% CI)

Overall					
		−.14 (−0.35, 0.07)	**−.21 (−0.42, −0.01)**	**−.24 (−0.47, −0.004)**	**−.66 (−0.78, −0.55)**
			−.07 (−0.32, 0.17)	−.09 (−0.37, 0.18)	**−.52 (−0.70, −0.35)**
				−.02 (−0.29, 0.24)	**−.45 (−0.62, −0.28)**
					**−.43 (−0.64, −0.22)**
					

Treatment					
		−.14 (−0.42, 0.13)	−.19 (−0.46, 0.07)	**−.34 (−0.63, −0.06)**	**−.81 (−0.95, −0.68)**
			−.05 (−0.35, 0.25)	−.20 (−0.51, 0.11)	**−.67 (−0.95, −0.39)**
				−.15 (−0.40, 0.11)	**−.62 (−0.82, −0.42)**

(continued)

Table 3 (continued)

Treatment	BM	BM SM	PE ADD BM RE SM	PE BM RE	NONE
PE BM RE					**−.47 (−0.69, −0.25)**
NONE					

Prevention	BM	BM SM	PE ADD BM RE SM	PE BM RE	NONE
BM		−.08 (−0.32, 0.16)	−.13 (−0.57, 0.31)	**−.33 (−0.63, −0.02)**	**−.43 (−0.63, −0.22)**
BM SM			−.05 (−0.49, 0.39)	−.25 (−0.54, 0.05)	**−.34 (−0.53, −0.15)**
PE ADD BM RE SM				−.2 (−0.66, 0.27)	−.30 (−0.74, 0.15)
PE BM RE					−.10 (−0.38, 0.18)
NONE					

Add, Additional components to enhance general parent and child skills; BM, Behavior management; NONE, No or minimal components (typically control condition); PE, Psychoeducation; RE, Relationship enhancement; SM, Parental self-management. Differential effects in bold indicate significant difference.

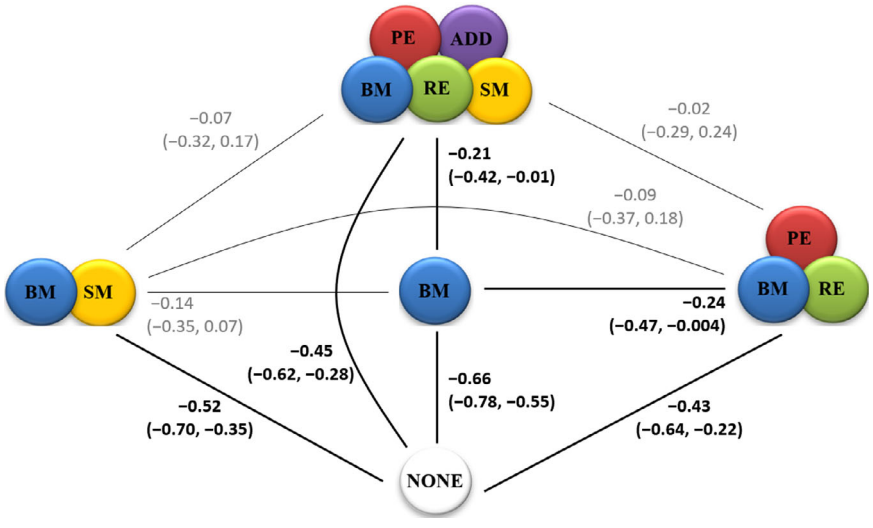

Figure 1 Relative effectiveness of different parenting program types for disruptive child behavior (treatment and prevention settings combined). Note. Add, additional components to enhance general parent and child skills; BM, Behavior management; NONE, No or minimal components (typically control condition); PE, Psychoeducation; RE, Relationship enhancement; SM, Parental self-management. Effects in bold are significant effects

Table 4 Probabilistic ranking of program effectiveness

	BM	BM SM	PE BM RE	PE ADD BM RE SM	NONE
Overall					
Best	**87%**	9%	2%	1%	0%
2nd	11%	**51%**	17%	21%	0%
3rd	1%	27%	31%	**41%**	0%
4th	0%	13%	**50%**	37%	0%
Worst	0%	0%	0%	0%	**100%**
SUCRA	0.97	0.64	0.43	0.47	0.00
Treatment					
Best	**79%**	17%	0%	4%	0%
2nd	19%	**42%**	5%	33%	0%
3rd	2%	30%	19%	**50%**	0%
4th	0%	12%	**75%**	13%	0%
Worst	0%	0%	0%	0%	**100%**
SUCRA	0.94	0.66	0.33	0.57	
Prevention					
Best	19%	**54%**	26%	1%	0%
2nd	**45%**	32%	19%	4%	0%
3rd	33%	12%	**33%**	20%	0%
4th	4%	1%	14%	**51%**	29%
Worst	0%	0%	8%	24%	**68%**
SUCRA	0.70	0.85	0.60	0.27	0.09

Add, additional components to enhance general parent and child skills; BM, Behavior management; NONE, No or minimal components (typically control condition); PE, Psychoeducation; RE, Relationship enhancement; SM, Parental self-management. Percentages in bold indicate most likely ranking of each cluster.

programs had the largest chance to be most effective in prevention settings. Across settings, more extensive programs had smaller chances to be most effective compared to controls.

Our finding that 'leaner' programs outperformed more extensive programs is in line with findings that sometimes "less is more" in parenting support (e.g. Bakermans-Kranenburg et al., 2003). One explanation for this might be that leaner programs allow parents to focus on the most essential program content, without the distraction of less important content. If parents are then able to implement behavior management techniques well, this might not only directly reduce disruptive

behavior through breaking parent–child interaction cycles but also indirectly through improving other family dynamics—when children become less disruptive, it becomes easier for parents to express warmth and sensitivity (Wiggins, Sofronoff, & Sanders, 2009). Elements of behavior management such as praise for positive child behavior might further contribute to this.

One explanation for why in prevention settings behavior management *with* parental self-management programs (versus in treatment settings behavior management *without* parental self-management) had the largest chance to be most effective, might be the type of families typically recruited for prevention purposes. Many prevention programs target families facing socioeconomic deprivation and other stressors (e.g. parental mental health problems). Components such as parental problem solving and stress management might support families in these challenges. In treatment settings, families' most urgent need is addressing severe levels of child disruptive behavior. This might be most effectively achieved by a specific focus on behavior management alone.

Parenting programs are more than the content included in their protocols—therapist skills and other 'common elements' may be as critical for program success as program content (Wampold, 2015). The current network meta-analysis focused specifically on program content, but a similar approach could be used in the future to identify naturally occurring variations in common elements, model how these tend to cluster, and what clusters of common elements most successfully change family dynamics.

Our identification of four key approaches could potentially serve as a template to map similarities and differences between programs and to understand their differential effects. We deployed an innovative and as yet uncombined set of methods for this—latent class analysis and network meta-analysis—to provide insights that single-component meta-regressions (Kaminski et al., 2008; Leijten et al., 2019) have not been able to offer.

Limitations of this study include the relatively low number of head-to-head trials in the literature. It is especially these trials that provide more direct evidence for the comparative effectiveness of programs. Second, we estimated the overall effectiveness of different combinations of components. In clinical practice, there may not be one optimal parenting program—what is optimal for each family may depend on complex interactions between family characteristics and components as well as on delivery components, which warrant testing in future. Testing individual family differences in optimal program content was beyond the scope of this study and requires a different level of analysis (e.g. at the individual participant data level). Third, and in common with all systematic reviews, our trial data may have been subject to publication and outcome reporting bias. We could not account for this. Importantly, however, the main goal of this study was to estimate the relative effects of different types of programs not the absolute magnitude of effects. Publication biases thus could affect our findings only if it differs per program type. Fourth, and finally, our latent class analysis relies on components as they currently cluster. As the field of intervention develops over time, new and heretofore unevidenced combinations may become relevant for analysis. For example, increased use of mindfulness-based techniques in parenting programs (Burgdorf, Szabó, & Abbott, 2019) might change the nature of the clusters in our analyses.

In sum, we used network meta-analysis to move the field beyond the study of program 'brands' and individual program components and identified the different program types that exist in this field based on variations in patterns of their program content. Comparative effectiveness and probabilistic ranking suggested that, in treatment settings, behavior management had the largest chance (79%) of being the most effective approach compared to no/minimal components, while behavior management with psychoeducation and relationship enhancement had no chance (0%) of being the most effective. In prevention settings, behavior management with parental self-management had the largest chance (54%) of being the most effective approach compared to controls, while programs with the maximum number of components included had the smallest chance (1%) of being the most effective. Because what is most effective for each family may depend on complex interactions between family characteristics and program components, testing individual family differences will be an important next step.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Figure S1. Flow chart of included trials.
Table S1. PRISMA–NMA checklist.
Table S2. Component coding scheme.
Table S3. Included studies.

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Author contributions

Conceptualization: GJMT and PL. Methodology, Software, and Formal Analysis: GJMT. Investigation and Data Curation: PL and GJMT. Writing—Original Draft: PL and GJMT. Writing—Review & Editing: PL, GJMT and FG. Visualization: PL. Supervision: FG. Project Administration: FG. Funding Acquisition: FG, PL, and GJMT.

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Key points

- Parenting programs vary in their components (i.e. techniques taught). We do not understand what combinations are most effective as prior meta-analyses mainly evaluated program 'brands' or single components.
- We used latent class analysis and network meta-analysis to (a) derive empirical clusters of components, (b) test comparative effectiveness of these clusters, and (c) rank the relative effects of these clusters.
- All active programs were more effective than no or minimal components. Programs with only behavior management components (overall and in treatment) or only behavior management and parental self-management components (in prevention) had the largest chance of being the most effective approach.
- Programs with the most components had the smallest chance of being the most effective.

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