JAMA Pediatrics | Original Investigation

Determining Associations Between Intervention Amount and Outcomes for Young Autistic Children
A Meta-Analysis

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IMPORTANCE Health professionals routinely recommend intensive interventions (ie, 20-40 hours per week) for autistic children. However, primary research backing this recommendation is sparse and plagued by methodological flaws.

OBJECTIVE To examine whether different metrics of intervention amount are associated with intervention effects on any developmental domain for young autistic children.

DATA SOURCES A large corpus of studies taken from a recent meta-analysis (with a search date of November 2021) of early interventions for autistic children.

STUDY SELECTION Studies were eligible if they reported a quasi-experimental or randomized clinical trial testing the effects of a nonpharmacological intervention on any outcome in participant samples comprising more than 50% autistic children 8 years or younger.

DATA EXTRACTION AND SYNTHESIS Data were independently extracted by multiple coders. Meta-regression models were constructed to determine whether each index of intervention amount was associated with effect sizes for each intervention type, while controlling for outcome domain, outcome proximity, age of participants, study design, and risk of detection bias. Data were analyzed from June 2023 to February 2024. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

MAIN OUTCOMES AND MEASURES The primary predictor of interest was intervention amount, quantified using 3 different metrics (daily intensity, duration, and cumulative intensity). The primary outcomes of interest were gains in any developmental domain, quantified by Hedges *g* effect sizes.

RESULTS A total of 144 studies including 9038 children (mean [SD] age, 49.3 [17.2] months; mean [SD] percent males, 82.6% [12.7%]) were included in this analysis. None of the meta-regression models evidenced a significant, positive association between any index of intervention amount and intervention effect size when considered within intervention type.

CONCLUSIONS AND RELEVANCE Findings of this meta-analysis do not support the assertion that intervention effects increase with increasing amounts of intervention. Health professionals recommending interventions should be advised that there is little robust evidence supporting the provision of intensive intervention.

Supplemental content

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JAMA Pediatr. doi:10.1001/jamapediatrics.2024.1832
Published online June 24, 2024.

Intensive interventions, provided for a minimum of 20 hours per week (up to as much as 40 hours per week), for a duration of at least 2 to 3 years (but potentially extending throughout early childhood), are regularly recommended to support development in young autistic children.[1-3] Although other intervention approaches are available to this population, the most commonly recommended approach for young autistic children in the US is Early Intensive Behavioral Intervention (EIBI),[4] which is characterized both by the type (ie, derived from the principles of Applied Behavior Analysis) and amount (eg, >30 hours per week) of intervention provided.

Although it is frequently implied that higher intervention amounts facilitate greater improvements in this population,[5] the evidence supporting these recommendations is largely restricted to small, quasi-experimental studies of behavioral interventions. The first recommendations for intensive intervention were based on the results of an early, nonrandomized study that reported that children who received 40 hours of behavioral intervention per week for 2 or more years and who began the intervention before the age of 4 years experienced greater cognitive gains than those who received only 10 hours of intervention per week for 2 years and began intervention after age 4 years.[6,7] Subsequent quasi-experimental studies comparing EIBI with eclectic intervention found mostly positive[8-18] and some null results,[19,20] but these studies confounded differences in intervention amount with differences in intervention approach.

A handful of studies have directly compared similar interventions offered at different amounts in this population, but they were largely quasi-experimental, restricted to studies of behavioral interventions, and yielded mixed results.[21-23] Two randomized clinical trials (RCTs) have compared EIBI with less intensive parent-directed behavioral interventions. One reported null results (potentially due to high amounts of nonproject treatment participation in the control group),[24] and the other reported positive and significant effects on IQ, visual-spatial skills, language ability, and school placement with greater amounts of treatment. However, subsequent retractions indicated that the initially reported benefits for language ability and school placement were incorrect.[25-27]

Only 1 RCT[28] published to date was adequately designed to test randomized comparisons of intervention amount separately from comparisons of intervention type. Rogers and colleagues[28] randomly assigned children to receive either 25 or 15 hours per week of 1 of 2 intervention approaches: EIBI or the Early Start Denver Model (a Naturalistic Developmental Behavioral Intervention ([NDBI]) for 2 years. Results indicated that participants demonstrated similar developmental progress on all measured outcomes regardless of intervention approach or amount.

It is important to consider that very intensive interventions could perceivably cause harm by depriving children of time to engage in other activities, such as rest, recreation, and time with family and community members. Intensive intervention could thereby reduce the number of natural opportunities for social interaction and inclusion, both of which can facilitate development and foster a sense of belonging. Although evidence of adverse effects and potential long-term harms have been poorly tracked in autism intervention studies,[29] some autistic adults have expressed that high-intensity interventions provided to them in childhood were harmful.[30]

Key Points

Question Is the amount of intervention provided to young autistic children associated with improved child development?

Findings Data from 144 studies of early childhood autism interventions featuring 9038 children gathered in a prior systematic review and meta-analysis were analyzed to determine whether the effects of common interventions were associated with any of 3 indices of intervention amount (ie, daily intensity, duration, cumulative intensity). None of the models evidenced a significant association between intervention amount and intervention effects.

Meaning There is not robust evidence that the benefits of early childhood interventions to young autistic children increase when those interventions are intensified; practitioners recommending interventions should consider what amounts would be developmentally appropriate.

Evidence From Meta-Analysis

Multiple meta-analyses[31-33] have examined the potential influence of intervention amount on traditional behavioral intervention effects, with mixed findings. Meta-analyses of other types of interventions, such as NDBIs and of general intervention effects (regardless of type) on specific outcome domains (such as language and social communication), have also broadly failed to find significant associations between intervention amount and intervention effects.[34-38]

Need for an Updated Meta-Analysis Examining the Association of Intervention Amount

Although multiple meta-analyses have been conducted to examine potential associations between intervention amount and effects for this population, most are relatively dated and restricted to a specific intervention approach (even though a wide variety of approaches are often available). We recently updated a comprehensive meta-analysis of all controlled-group studies of all nonpharmacological interventions targeting any outcome in young autistic children (ages 0-8 years).[39,40] Our findings suggested that the number of available studies in this area has doubled in the last 5 years and quadrupled in the last decade. Although we have yet to fully explore whether intervention effects represented in this dataset were associated with the amount of intervention provided in each study, our preliminary analyses of the initial dataset suggested that effects did not significantly vary by intervention amount.[41]

Intervention amount can vary along several dimensions, and the potential influence of intervention amount on intervention effects may depend on the dimension being examined.[42] To distinguish between these dimensions, we refer to the amount of intervention (in hours) provided within a given time frame (eg, 1 hour per day) as *intensity*. *Duration* refers to the total amount of time (in days) that intervention is provided (eg, 365 days). *Cumulative intensity* combines these

metrics to describe the total amount of intervention (in hours) provided over the total duration that intervention is provided (eg, 365 hours provided in total).

The purpose of this investigation was to explore whether each of these 3 indices of intervention amount were associated with intervention effects for autistic children, and whether the strength of association varies by intervention approach, using findings from controlled group studies of interventions for this population and advanced meta-analytic techniques. Our analysis focused on the 4 broad intervention approaches with the most available evidence (NDBIs, behavioral interventions, technology-based interventions, and developmental interventions). Considering effects of intensity while accounting for differences in intervention approach is important, given that the logic about the cumulative benefit of added intervention hours varies by approach. For example, behavior analytic theories of change suggest that behavioral intervention effects should increase with intensity of clinician-delivered intervention, as higher intensities will provide increased opportunities to strengthen behavior-reward associations and, therefore, increase the occurrence of desired behaviors. In contrast, theories underpinning developmental interventions suggest that benefit is derived from generalized, holistic changes in caregiver-child interactions, and therefore, increased clinician hours are unlikely to increase their benefit. Given that the nature of this association may also depend on the proximity of the outcome to the targets of the intervention (where more intensive interventions could have larger effects on distal outcomes, and less intensive interventions could have larger effects on proximal outcomes), we also sought to control for outcome domain and outcome proximity. Theory suggests that intervention may be more beneficial to younger children, when plasticity is presumably at its height. Therefore, we also sought to control for participant age. Finally, because there are substantial quality concerns about the available literature (specifically, an overrepresentation of quasi-experimental studies and overreliance on unmasked assessors), we sought to control for potential risks of selection and detection bias.

Methods

Study Sample

This meta-analytic investigation leverages data from a prior meta-analysis of all controlled group studies that tested the effects of any nonpharmacological intervention on any outcome for young autistic children (up to age 8 years), published before November of 2021 (the most recent search date).[40] We included findings related to the 4 most common intervention types and restricted our analysis to commonly reported outcomes. As such, we excluded findings for academic, brain imaging, sensory, sleep, and other outcome domains that were infrequently reported. Study inclusion criteria and relevant search terms are detailed in **Table 1.** We further excluded data from 2 studies that did not report mean age of participants. Race and ethnicity data were not included in this analysis as these data were not uniformly reported among included studies. In addition, because race and ethnicity categorization systems vary by region/nation and included studies were not limited to the US, reporting categories varied widely and simple tallying of participants according to categories was not possible. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guidelines, and the PRISMA diagram is published in the parent meta-analysis.[40]

Table 1. Study Inclusion Criteria and Search Terms

Dimension[a]	Criterion	Search terms[b]
Participants	Autism	autis* ASD PDD Aspergers
Intervention	Any nonpharmacological intervention	Intervention therapy teach* treat* program package
Comparison	Usual treatments or control	assign* "control group" BAU "wait list" RCT random* quasi "treatment group" "intervention group" "group design" trial
Outcome	Any outcome	(None)
Study design	Any group-design study	(None)

Abbreviations: ASD, autism spectrum disorder; BAU, business as usual; PDD, pervasive developmental disorder; RCT, randomized clinical trial.

[a] Within each dimension, search terms were joined with Boolean OR operator.

[b] Search strings from each dimension were joined with Boolean AND operator.

Coding Procedures

Studies were coded for identifying information, intervention characteristics, participant characteristics, and various risks of bias. Descriptive information reflecting the quality of the included studies is detailed in eFigure 1 in Supplement 1). Outcomes were coded for domain and categorized as either proximal or distal to intervention targets. Interventions were coded for type and amount provided across 3 metrics (daily intensity, duration, and cumulative intensity). We extracted relevant information necessary to calculate effect sizes (Hedges *g*) reflecting the difference between intervention and comparison groups at the end of the study for each reported outcome. Coding procedures are described in detail in eTable 2 in Supplement 1, as well as in the report of the original meta-analysis.[40] A copy of the coding manual and the corresponding dataset is available in an open-access repository.[43]

Statistical Analysis

Preliminary analyses are detailed in eTable 2 in Supplement 1. For each of the 3 metrics of intervention amount (daily intensity, duration, cumulative intensity), we estimated a meta-regression model describing linear associations between effect size magnitude and the log base 2 of intervention amount, averaged to the study level, with separate slopes for each intervention type. We used log base 2 transformation to reduce

the skew of the predictor distributions; coefficients can therefore be interpreted as predicted differences in effect size between studies that differ by a factor of 2 in intervention amount (eg, daily intensity of 2 hours per day vs 1 hour per day or 4 hours vs 2 hours). We also estimated a model that included additive effects for intervention daily intensity and intervention duration, with each dimension on the log base 2 scale. All meta-regression models included controls for outcome proximity (proximal vs distal), study design (RCT vs quasi-experiment), detection bias (low vs high/unclear), mean age of participants (in months, centered at 48 months) as well as fixed effects for each combination of outcome domain and intervention type.

We estimated all meta-regression models using a correlated and hierarchical effects (CHE) working model approach[44] to account for the dependence structure of the effect size estimates drawn from each study. For meta-regression analysis, effect sizes were weighted by the inverse of the sampling variance-covariance under the CHE working model; this approach allocates greater weight to studies with larger sample sizes and with a larger number of outcomes. All models were estimated using restricted maximum likelihood methods with the statistical packages clubSandwich[45] and metafor[46] in the R statistical computing software (R Project for Statistical Computing).[47] For hypothesis tests, we used Approximate Hotelling T^2 tests with a cluster-robust (CR2)-type robust variance estimation.[48] All significance tests were 2-tailed with α = .05 cutoffs for statistical significance. Data were analyzed from June 2023 to February 2024.

Results

Across the 4 eligible intervention types, the final sample of studies included a total of 175 reports, reporting the outcomes of 144 separate studies (where some studies were reported across multiple reports detailing immediate and subsequent longitudinal outcomes) (eTable 1 in Supplement 1). A total of 9038 participants (mean [SD] age, 49.3 [17.2] months; mean [SD] percent males, 82.6% [12.7%]) were represented in the study sample, and a total of 2137 effect sizes were extracted to index intervention effects on measured outcomes. eTable 3 in Supplement 1 indicates the intervention and outcome types represented in the present analyses and the number of effects parsed by cell. eTable 4 in Supplement 1 reports the percentage of studies and outcomes for which we were able to derive metrics of intervention amount and the distribution of intervention amounts for each intervention type. Intervention duration could be derived for almost all included studies (97%), but daily intensity and cumulative intensity could be determined for less than two-thirds of studies, including approximately three-quarters of included outcomes. Across metrics, the distributions of intervention amounts varied depending on intervention type. Compared with other intervention types, behavioral interventions tended to be studied at higher levels of daily intensity; behavioral and developmental interventions were studied for longer durations and higher cumulative intensity.

eFigure 2 in Supplement 1 depicts the distributions of each metric of intervention amount. eFigure 3 in Supplement 1 depicts the joint distribution of daily intensity and duration for each intervention type. Further information regarding heterogeneity and sensitivity analyses are detailed in eTable 5 in Supplement 1.

Results of our main analyses are detailed in **Table 2**. All models indicated a high degree of variation in effect sizes after controlling for intervention amount within each intervention type. **Figure 1**, **Figure 2**, and **Figure 3** depict the estimated association between effect size magnitude and intervention daily intensity (Figure 1), intervention duration (Figure 2), or cumulative intensity (Figure 3).

Intervention Daily Intensity

In the model including intervention daily intensity (ie, hours per day) as the focal predictor (Table 2), daily intensity was not significantly associated with effect sizes for any of the intervention types. Technology-based interventions evidenced the largest positive association (β = 0.10; SE = 0.09; 95% CI, −0.09 to 0.29), but this was not statistically distinguishable from zero (P = .27). A joint test across intervention types did not reject the possibility that all associations were zero ($F_{4,\ 15.9}$ = 1.13; P = .38). We also could not rule out the possibility that slopes were equal across intervention types ($F_{3,\ 16.3}$ = 1.49; P = .26). This pattern of results was consistent in a model that also controlled for intervention duration (Table 2).

Intervention Duration

In the model including intervention duration (ie, total days of intervention) as the focal predictor (Table 2), duration was not significantly associated with effects for 3 of the 4 intervention types. For technology-based interventions, duration was negatively associated with intervention effects (β = −0.118; $t_{4.8}$ = −4.06; P = .01; 95% CI, −0.19 to −0.04). However, a joint test across intervention types did not reject the possibility that all associations were zero ($F_{4,\ 12.1}$ = 3.04; P = .06). We could also not rule out the possibility that slopes were equal across intervention types ($F_{3,\ 11.9}$ = 2.13; P = .15). This pattern of results was consistent in a model that also controlled for intervention daily intensity (Table 2). In particular, the negative association between duration and effect magnitude remained stable and statistically distinguishable from zero (β = −0.12; $t_{5.5}$ = −2.99; P = .03; 95% CI, −0.22 to −0.02).

Cumulative Intervention Intensity

In the model including cumulative intensity (ie, total hours of intervention provided over the course of the study) as the focal predictor (Table 2), cumulative intensity was not significantly associated with effectiveness for any intervention type. A joint test across intervention types did not reject the possibility that all associations were zero ($F_{4,\ 11.6}$ = 1.58; P = .24). We could also not rule out the possibility that slopes were equal across intervention types ($F_{3,\ 9.8}$ = 1.79; P = .21).

Table 2. Estimated Slopes for Dosage-Related Variables by Intervention Types, Based on Meta-Regressions Using a Correlated and Hierarchical Effects Working Model[a]

Variable	Mean effect size estimate (SE) [95% CI]			
	Daily intensity	Duration	Cumulative intensity	Daily intensity and duration
Daily intensity (log base 2 scale)				
NDBI	0.04 (0.05) [−0.06 to 0.14]	NA	NA	0.06 (0.05) [−0.05 to 0.17]
Behavioral	−0.03 (0.06) [−0.17 to 0.10]	NA	NA	−0.02 (0.07) [−0.17 to 0.12]
Technology-based	0.10 (0.09) [−0.09 to 0.29]	NA	NA	0.05 (0.10) [−0.18 to 0.28]
Developmental	−0.11 (0.06) [−0.25 to 0.04]	NA	NA	−0.12 (0.06) [−0.31 to 0.06]
Duration (log base 2 scale)				
NDBI	NA	−0.04 (0.04) [−0.13 to 0.04]	NA	−0.09 (0.05) [−0.19 to 0.02]
Behavioral	NA	−0.05 (0.05) [−0.15 to 0.05]	NA	−0.07 (0.09) [−0.27 to 0.13]
Technology-based	NA	−0.12 (0.03) [−0.19 to −0.04]	NA	−0.12 (0.04) [−0.22 to −0.02]
Developmental	NA	0.04 (0.06) [−0.15 to 0.22]	NA	−0.05 (0.04) [−0.19 to 0.09]
Cumulative intensity (log base 2 scale)				
NDBI	NA	NA	0.01 (0.02) [−0.04 to 0.06]	NA
Behavioral	NA	NA	−0.06 (0.04) [−0.15 to 0.03]	NA
Technology-based	NA	NA	−0.07 (0.05) [−0.21 to 0.06]	NA
Developmental	NA	NA	−0.09 (0.04) [−0.21 to 0.03]	NA
Unexplained heterogeneity				
Between-study SD	0.21	0.21	0.22	0.21
Within-study SD	0.25	0.26	0.25	0.25
Total SD	0.33	0.34	0.33	0.33
No. studies	92	142	95	92
No. outcomes	1559	2062	1587	1559

Abbreviations: NA, not applicable; NDBI, naturalistic developmental behavioral intervention.

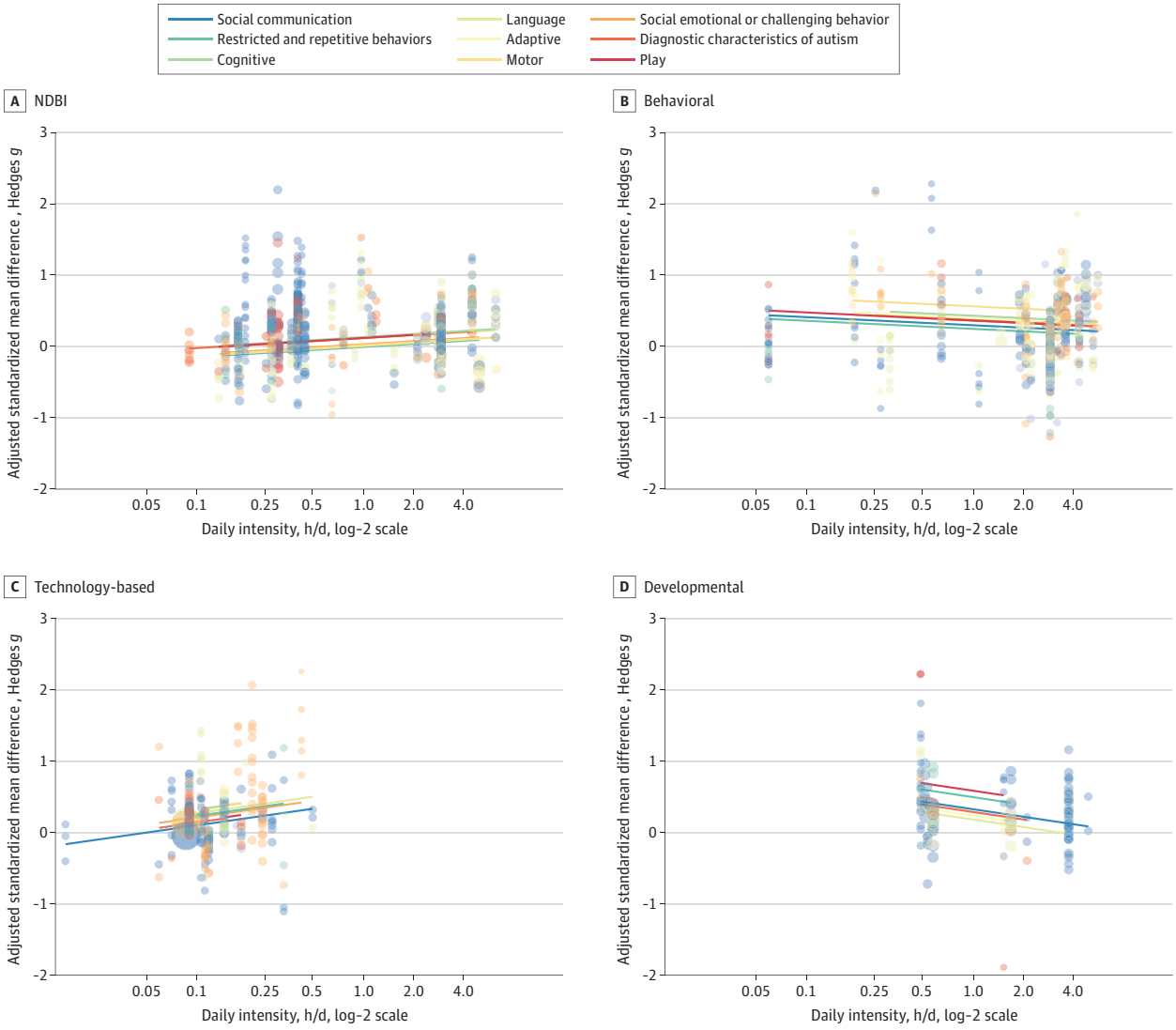
[a] Daily intensity, duration, and cumulative intensity predictors are on a log base 2 scale. All models control for outcome type (proximal vs distal), study design (randomized clinical trial vs quasi-experimental), detection bias (low vs unclear or high), mean age of participants, and the interaction of outcome domain and intervention type.

Discussion

The purpose of this meta-analysis was to examine the extent to which intervention amount was associated with intervention effects in young autistic children, using advanced meta-analytic methods and a comprehensive dataset of controlled group studies of nonpharmacological interventions for young autistic children. Guidelines frequently recommend that high-intensity interventions be provided to this population[1,3,5]; although, more recent guidelines have noted that evidence supporting such recommendations is generally weak.[30] Understanding the potential association of intervention amount with intervention effects is necessary in order to weigh potential benefits offered by intensive intervention with potential opportunity costs and any possible harms. Because we recognized that the association of intervention amount with intervention effects may depend on the index of amount (ie, daily intensity, duration, or cumulative intensity), may vary by intervention type, and may be further complicated by the type and proximity of outcomes measured in studies, the age of participants, and the quality of included studies, we built meta-regression models that accounted for all of these factors. We failed to find robust evidence that intervention amount was associated with intervention effects, regardless of intervention approach or outcome type. We identified only 1 statistically significant association, which indicated that longer-duration interventions were associated with reductions in effectiveness for technology-based interventions. Considering the number of associations tested and the absence of multiplicity corrections, we urge caution in focusing on this specific finding.

Our findings broadly align with those of a recent study,[49] which found that the amount of intervention provided in early childhood did not significantly predict developmental outcomes in autistic children at ages 5 to 7 years, as well as conclusions of a recent umbrella review[30] of nonpharmacological interventions for young autistic children. In addition, they replicate the findings of some prior meta-analyses investigating the association of intervention amount with intervention effects of behavioral interventions,[32] of NDBIs,[34] and of general intervention effects on language[36,37] and social communication.[35] However, they stand in contrast to the results of some quasi-experimental studies and meta-analyses that suggest that high-intensity behavioral interventions are associated with greater gains than lower-intensity behavioral

Figure 1. Adjusted Effect Size Estimates as a Function of Intervention Daily Intensity, by Intervention Type



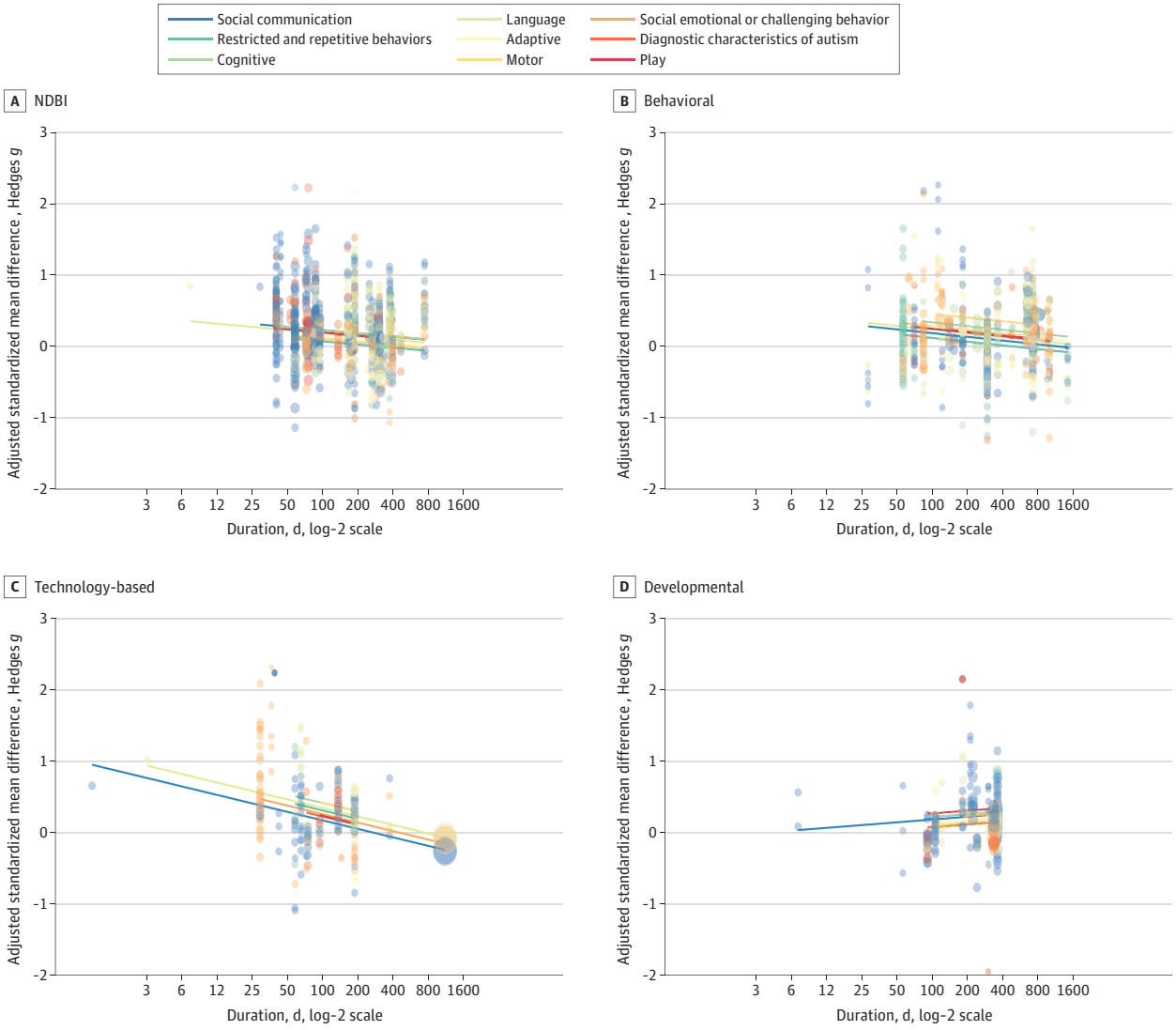
Effect size estimates are adjusted based on a model controlling for outcome type (proximal vs distal), study design (randomized clinical trial vs quasi-experimental), detection bias (low vs unclear or high), average age of participants, and the interaction of outcome domain and intervention type.

Adjusted estimates are predictions for proximal outcomes, randomized clinical trial designs, low detection bias, and an average of 48 months. NDBI indicates naturalistic developmental behavioral intervention.

interventions.[31,33,50] It is notable that the only RCT[28] explicitly designed to test this question documented no significant differences in gains on any outcome, on average, between children who received 15 vs 25 hours of EIBI per week for 2 years. However, this study[28] was relatively small (approximately 20 participants per arm), and larger replications are needed to more precisely estimate the causal impact of intervention amount on intervention efficacy.

Given the complicated landscape of evidence, how should professionals guide families seeking effective support for their children? Although we did not find evidence that increasing amounts of intervention were associated with increasing benefits, this should not be interpreted as evidence that autistic children should be left without support. Multiple high-quality studies in our sample attested to the effects of some intervention approaches offered at various intensities for young autistic children. In addition, autistic adults have also described feeling harmed by the provision of too little support during childhood.[30] Practitioners should be especially careful to calibrate an appropriate amount of support for autistic people with high support needs, especially those who are at risk of injury if left unsupported.[51] It is likely that there is a minimum amount needed for intervention to have any benefit at all and, potentially, an optimal amount of intervention that is dependent on the child. Unfortunately, current evidence does not offer clear values or ranges for those amounts. Clinicians and medical professionals should fully inform families that guidelines that prescribe specific amounts or increasing daily

Figure 2. Adjusted Effect Size Estimates as a Function of Intervention Duration, by Intervention Type



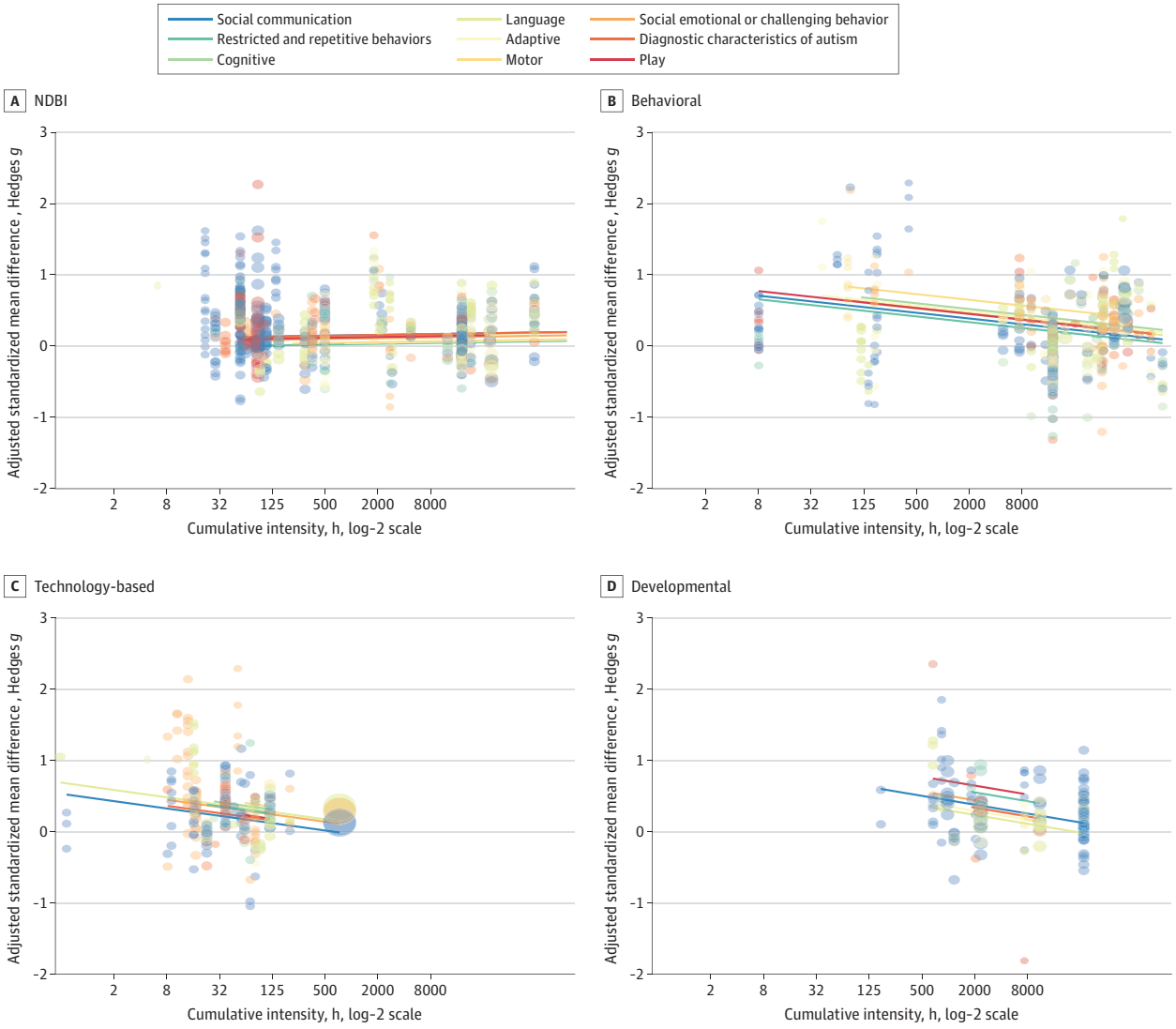
Effect size estimates are adjusted based on a model controlling for outcome type (proximal vs distal), study design (randomized clinical trial vs quasi-experimental), detection bias (low vs unclear or high), average age of participants, and the interaction of outcome domain and intervention type.

Adjusted estimates are predictions for proximal outcomes, randomized clinical trial designs, low detection bias, and an average of 48 months. NDBI indicates naturalistic developmental behavioral intervention.

intensity as optimal are not supported by current evidence. This will allow families to make informed decisions about what amounts might be both beneficial and feasible for their child to receive.

In terms of US early childhood intervention policy, guidelines recommending the provision of high-intensity interventions did not have robust supporting evidence[29,40] when first provided, and few studies that rigorously test differential effects of intensity have been conducted since. Future primary studies should be designed to carefully and powerfully test potential continuous interactions between intensity and intervention effects. Additionally, no studies, to our knowledge, have been conducted that carefully monitor the potential adverse effects and harms of this aspect of intervention planning. The lack of evidence examining harms is an important consideration, given that recent studies have shown that other intervention recommendations that were similarly endorsed without robust evidentiary backing are now thought to be counterproductive (ie, the use of telegraphic speech[52,53] and monolingual support for children of multilingual families[54]). Further, it is possible that beneficial interventions can become harmful when provided at intensities that are too high (referred to as *overdosing* in pharmacological treatment[55]). Practitioners should, therefore, exercise caution in recommending intensive interventions and consult closely with families to calibrate individualized supports for autistic children at an intensity that evidences individual benefit without impinging on activities and routines in home, educational, and com-

Figure 3. Adjusted Effect Size Estimates as a Function of Intervention Cumulative Intensity, by Intervention Type



Effect size estimates are adjusted based on a model controlling for outcome type (proximal vs distal), study design (randomized clinical trial vs quasi-experimental), detection bias (low vs unclear or high), average age of participants, and the interaction of outcome domain and intervention type.

Adjusted estimates are predictions for proximal outcomes, randomized clinical trial designs, low detection bias, and an average of 48 months. NDBI indicates naturalistic developmental behavioral intervention.

munity settings that are important for their thriving. In addition, potential harms of interventions for autistic children at any amount are largely unknown.

Limitations

In failing to find evidence supporting an association between intervention amount and intervention effects, we have not proven that such associations are null. It is possible that the amount of intervention provided was associated with effects for some intervention approaches, but several factors inhibited our ability to detect potentially true associations. For example, one study limitation was that we were often unable to extract daily and cumulative intensity from studies that failed to report this information, and this was especially the case for studies of NDBIs and developmental interventions. Many of the interventions detailed in these study subgroups were either partially or fully mediated by caregivers. Caregiver-mediated intervention studies that failed to report the recommended or actual amount of time caregivers delivered intervention were considered nonreporting, as extracting only clinician-delivered hours from such studies would have poorly estimated intervention amount. In future investigations, researchers should clearly describe all aspects of intervention amount across all interventionists (caregivers included).

An additional limitation is that our analysis treated caregiver-mediated intervention hours as equivalent to clinician-delivered intervention hours, even though they are likely distinct. Although we felt it was important that we included both

caregiver- and clinician-delivered hours in estimation of intervention intensity, we recognize that they may have differential impacts on intervention efficacy. However, the distinction between clinician- and caregiver-delivered intervention hours is further complicated by intervention approach. For example, in some studies of EIBI, caregivers were trained to operate as proxy clinicians (eg, by providing discrete trial training to their children).[8,9,13] In these examples, caregiver-delivered hours may be considered similar to clinician-delivered hours. However, in many studies of caregiver-mediated developmental interventions, clinicians rarely interacted with children directly.[56-58] Instead, caregivers delivered intervention by altering their interaction styles within the context of daily routines. The precise intensity with which caregivers effectively implemented intervention strategies in everyday interactions is somewhat difficult to quantify, beyond the time that was explicitly prescribed for practice and/or that caregivers reported using strategies with their child (which may not reflect actual time spent). Further, these interventions, even when they are delivered with relatively high intensity, may be less likely to interrupt child participation in everyday family activities and instead simply alter the nature of their participation. Our methods did not allow us to differentially examine the impact of clinician-delivered vs caregiver-delivered intervention hours, but future investigations should more closely examine this question. In the meantime, it is important to reiterate that relatively intense interventions may look dramatically different depending on the intervention approach and implementer.

It is also possible that the potential influence of intervention amount on intervention effects varies by participant characteristics, such as age. Although theory suggests intervention may be more beneficial when provided at younger ages, few studies have been adequately designed to experimentally test this question and meta-analytic evidence does not support it.[34,41,59] For this reason, we included age as a covariate and failed to find evidence suggesting a differential impact of intervention intensity by this variable. Future studies that are designed to directly test differential impacts of intensity should adequately power their analyses to account for possible interactions with relevant participant characteristics.

Conclusions

Findings of this meta-analysis do not support the assertion that intervention effects increase with increasing amounts of intervention. Health professionals recommending interventions should be advised that there is little robust evidence supporting the provision of intensive intervention.

ARTICLE INFORMATION

Accepted for Publication: March 20, 2024.

Published Online: June 24, 2024. doi:10.1001/jamapediatrics.2024.1832

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Drafting of the manuscript: Sandbank, Pustejovsky, Bottema-Beutel, Caldwell, Feldman, Woynaroski.
Critical review of the manuscript for important intellectual content: Sandbank, Pustejovsky, Bottema-Beutel, Caldwell, Crowley LaPoint, Woynaroski.
Statistical analysis: Pustejovsky, Feldman.
Administrative, technical, or material support: Sandbank, Bottema-Beutel, Caldwell, Feldman.
Supervision: Sandbank, Woynaroski.

Conflict of Interest Disclosures: Dr Sandbank reported receiving personal fees from National Disability Insurance Agency, Australia for providing expert testimony on efficacy of early intervention outside the submitted work, receiving speaker fees from the New Jersey Autism Center for Excellence and Children's Healthcare of Atlanta, and directing a university program that provided coursework necessary for certification from the Behavior Analyst Certification Board. Dr Bottema-Beutel reported receiving book royalties from Springer Publishing, travel fees from American Speech-Language Hearing Association, speaker fees from Marcus Autism Center, New Jersey Autism Center for Excellence, Meeting on Inclusive Research in Autism, University of Massachusetts, and San Diego State National Student Speech Language Hearing Association outside the submitted work. Dr Caldwell reported being president of the Arkansas Association for Behavior Analysis and receiving payment from the University of Arkansas to consult and supervise teams that provided behavioral health services to children diagnosed with autism. Dr Feldman reported receiving grants from the National Institutes of Health (NIH)/National Center for Advancing Translational Sciences and grants from NIH/National Institute on Deafness and Other Communication Disorders outside the submitted work; being the parent of an autistic child; receiving payment from Special Equestrians and Saddle Up! to provide adaptive horseback riding lessons; and being employed by the Department of Hearing and Speech Sciences at Vanderbilt University Medical Center. Dr Crowley LaPoint reported being formerly affiliated with an entity that trained students to become board-certified behavior analysts; providing Early Intensive Behavioral Intervention; being employed by the TEACCH Autism Program; and serving as an interventionist on an intervention developed at TEACCH for autistic transition-age youth. Dr Woynaroski reported receiving nonfinancial support from Vanderbilt University Medical Center; being employed by the Department of Hearing and Speech Sciences at Vanderbilt University Medical Center; being the parent of an autistic child; having previously been paid to provide traditional behavioral, naturalistic developmental behavioral, and developmental interventions to young children on the autism spectrum; and receiving grant funding from internal and external agencies, including the National Institutes of Health and the Vanderbilt Institute for Clinical and Translational Research, to study the efficacy of various interventions geared towards young children with autism. No other disclosures were reported.

Funding/Support: This work was supported in part by grant TL1TR002244 from the National Center for Advancing the Translational Sciences of the National Institutes of Health.

Role of the Funder/Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Disclaimer: The contents are solely the responsibility of the authors and do not represent the official views of the National Center for

Advancing the Translational Sciences or the National Institutes of Health.

Data Sharing Statement: See Supplement 2.

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