This article reviews current evidence for autism spectrum disorder (ASD) interventions for children aged <3 years, based on peer-reviewed articles published up to December 2013. Several groups have adapted treatments initially designed for older, preschool-aged children with ASD, integrating best practice in behavioral teaching methods into a developmental framework based on current scientific understanding of how infants and toddlers learn. The central role of parents has been emphasized, and interventions are designed to incorporate learning opportunities into everyday activities, capitalize on “teachable moments,” and facilitate the generalization of skills beyond the familiar home setting. Our review identified several comprehensive and targeted treatment models with evidence of clear benefits. Although some trials were limited to 8- to 12-week outcome data, enhanced outcomes associated with some interventions were evaluated over periods as long as 2 years. Based on this review, recommendations are proposed for clinical practice and future research. *Pediatrics* 2015;136:S60–S81

**AUTHORS:** Lonnie Zwaigenbaum, MD, Margaret L. Bauman, MD, Roula Choueiri, MD, Connie Kasari, PhD, Alice Carter, PhD, Doreen Granpeesheh, PhD, BCBA-D, Zoe Mailloux, OTD, OTR/L, FAOTA, Susanne Smith Roley, OTD, OTR/L, FAOTA, Sheldon Wagner, PhD, Deborah Fein, PhD, Karen Pierce, PhD, Timothy Buie, MD, Patricia A. Davis, MD, Craig Newschaffer, PhD, Diana Robins, PhD, Amy Wetherby, PhD, Wendy L. Stone, PhD, Nuri Yirmiya, PhD, Annette Estes, PhD, Robin L. Hansen, MD, James C. McPartland, PhD, and Marvin R. Natowicz, MD

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**ABBREVIATIONS**

ABA—applied behavior analysis
ASD—autism spectrum disorder
ESDM—Early Start Denver Model
GRADE—Grading of Recommendations Assessment, Development, and Evaluation

(Continued on last page)
The ultimate goal of early detection and screening is to ensure that children with autism spectrum disorder (ASD) can access evidence-based interventions to provide the best opportunity for optimal development and outcomes.1 With the advances reviewed by Zwaigenbaum et al2,3 in this special issue of Pediatrics, and the growing evidence that ASD can be diagnosed accurately before 2 years of age,4,5 the need for ASD treatment programs specifically designed for this age group has never been greater. Some authors have also argued that the second year of life is a particularly critical developmental period for children with ASD, for various reasons. First, the second year is a dynamic period of brain growth, during which increases in brain volume and atypical connectivity associated with ASD first emerge6,7 but also a time of substantial neural plasticity providing greater potential to alter developmental course.8 Second, a proportion of children with ASD reported to regress in the second year. Recent research has indicated only modest agreement between retroactively reported regression and analysis of behavioral change as observed on serial home videos9 and that acute skill loss may exist along a continuum of gradually declining trajectories of social and communicative behavior.10,11 However, interventions during this period may counter the developmental cascade that contributes to progressive symptom development and ultimately prevent ASD-related impairments before they fully manifest.8 Intervention approaches for children aged <2 to 3 years need to be developmentally appropriate. We cannot assume that findings from treatment research involving older children with ASD will generalize to infants and toddlers, who differ with respect to the nature of their social relationships as well as their cognitive and communicative processes. Infants depend on experiential learning within their natural environments and on interactions rooted in social play that occur within the context of everyday caregiving activities.1 Fortunately, over the past several years, a growing number of studies have evaluated interventions specifically designed for children aged <2 to 3 years. An updated review of these interventions may provide needed direction and guidelines to clinicians and policy makers.

**METHODS**

The working group conducted a search of the literature published online between 2000 and 2012 related to intervention programs provided to children with ASD aged <3 years. The working group summarized published research on interventions developed for use in children aged <36 months, even if the age range of samples of children being evaluated extended beyond age 3 years (Table 1). A PubMed search was conducted on June 30, 2010, for articles published since January 1, 2000, by using the search terms (“child developmental disorders, pervasive” or “autistic disorder” or “autism [tw]” or “autistic [tw]”) and (“Early Intervention” or “intervention [tw]”), with an age filter (“infant, birth-23 months” or “Preschool child, 2-5 years”) and limited to English-language articles. This search yielded 419 references, which were reviewed by Drs Zwaigenbaum and Bauman, who selected articles focusing on clinical trials of developmental/behavioral interventions (ie, not medications or trials of other biomedical therapies) that included children aged <36 months. Search results were complemented by additional publications identified by working group members. Hence, although the search strategy was comprehensive, selection of articles was not systematic, which is an important limitation. A scoping approach, with some discretion of the multidisciplinary expert working group, was used instead to select articles of highest relevance.

Each selected study was assessed, and working group members were asked to arrive at a consensus evaluation on each article after a detailed discussion. The search was updated by using the same strategy to add articles published to December 31, 2013, which yielded an additional 323 references; selection was again limited to clinical trials of developmental/behavioral interventions that included children aged <36 months. The working group reviewed and approved the final wording of the summary and recommendations.

We recognize that in addition to comprehensive early intervention programs, the management and treatment of young children with ASD often involves speech and language and occupational and physical therapies, as well as management of comorbid conditions such as associated medical disorders (eg, sleep, gastrointestinal),12 anxiety, and challenging and maladaptive behaviors. However, a review of these targeted interventions was beyond the scope of the current initiative.

**LITERATURE REVIEW**

Table 1 summarizes the key features and outcomes of 24 randomized controlled, quasi-experimental, and open-label studies involving children with ASD aged <3 years reviewed by the working group.13–58 Because few studies focused exclusively on this age group, studies in which participants included some children aged >3 years were assessed as long as there was sufficient information to draw inferences about younger children. The group reviewed additional reports, which have not been listed in Table 1, including single-subject studies,59–64 other relevant studies,16,45–50 meta-analyses,51,52 and reviews.53–56
<table>
<thead>
<tr>
<th>Reference</th>
<th>N, Chronological Age, Gender</th>
<th>Design</th>
<th>Dose</th>
<th>Treatment</th>
<th>Outcomes</th>
<th>Degree of Parental Involvement</th>
<th>Comments</th>
<th>GRADE Quality of Evidence</th>
<th>GRADE Recommendation</th>
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<tr>
<td>Rogers et al, 2012</td>
<td>N = 98 with ASD (screen-positive on the ITQ and ESAT and diagnosis by using ADOS-T and clinical judgment) Aged 12–24 mo (mean: 21.0 mo); 76 boys</td>
<td>RCT</td>
<td>1 h parent training per week × 12 wk, plus self-instruction manual for parent to review</td>
<td>Comprehensive ESDM (see Dawson et al, below), adapted as briefer parent training model</td>
<td>No main treatment effects on parent acquisition of ESDM intervention skills nor improvement in child development or ASD symptoms</td>
<td>Implemented by parents</td>
<td>Both groups showed improvement in child outcomes, related to hours of intervention and older child age at baseline</td>
<td>Moderate/high</td>
<td>Weak</td>
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<tr>
<td>Carter et al, 2011</td>
<td>N = 62 with ASD symptoms or at risk (STAT) Aged 15–25 mo (mean: 20.3 mo); 51 boys</td>
<td>RCT</td>
<td>1 group session with parents per week × 8 wk, plus 3 at-home individualized sessions for parent and child</td>
<td>Targeted Hanen recommendations: parent training in small groups plus 1:1</td>
<td>No main treatment effects on parent responsivity or child communication outcomes immediately or 5 mo after treatment (although moderate to large effect sizes for parent responsivity gains)</td>
<td>Implemented by parents</td>
<td>Missing data precluded ITT analysis</td>
<td>Moderate/high</td>
<td>Weak</td>
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<tr>
<td>Landa et al, 2011</td>
<td>N = 48 with ASD</td>
<td>RCT</td>
<td>10 h/week × 6 mo</td>
<td>Targeted Social curriculum (5:3, DTT, routines-based interactions) added to comprehensive classroom-based intervention (AEPS)</td>
<td>Significant (P = .02) between-group difference for socially engaged imitation (moderate effect size at 6 mo, large effect size at 12 mo)</td>
<td>Implemented by interventionists</td>
<td>Control group without social curriculum nevertheless received some imitation and JA intervention</td>
<td>Moderate/high</td>
<td>Weak</td>
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<tr>
<td>Dawson et al, 2010</td>
<td>N = 48 with ASD</td>
<td>RCT</td>
<td>20 h/week × 2 y (therapists) plus ≥5 h/wk × 2 y (parents)</td>
<td>Comprehensive</td>
<td>ESDM: 1:1, home-based, ABA and developmental approaches; plus other available therapies</td>
<td>Significant between-group differences in IQ and adaptive behavior after 2 y</td>
<td>Delivered by therapists and parents</td>
<td>Group differences larger than those in studies of comparable developmental behavioral approaches of shorter duration and fewer hours of delivery per week</td>
<td>Moderate/high</td>
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<tr>
<td>Green et al, 2010</td>
<td>N = 152 with AD</td>
<td>RCT</td>
<td>4 h/month × 6 mo, then 2 h/month × 6 mo</td>
<td>Targeted</td>
<td>PACT: intervention to increase parent sensitivity and responsiveness; 1:1 with child present, plus treatment as usual</td>
<td>NS between-group difference in child autism symptom severity, language measures, or adaptive functioning in school at 15 mo</td>
<td>Parent mediated</td>
<td>AOS-Q used as primary outcome, may not be sensitive measure of change</td>
<td>Moderate/high</td>
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<tr>
<td>Ingersoll, 2010</td>
<td>N = 21 with AD</td>
<td>RCT</td>
<td>3 h/week × 10 wk</td>
<td>Targeted</td>
<td>Behavioral intervention (RIE): laboratory setting, naturalistic techniques</td>
<td>Significantly more gains in elicited (P &lt; .05) and spontaneous (P &lt; .02) imitation, in both object (P &lt; .05), and gesture (P &lt; .01) imitation compared with controls</td>
<td>Implemented by therapists</td>
<td>Groups not matched pretreatment (better imitation in RIT group)</td>
<td>Moderate/high</td>
</tr>
<tr>
<td>Kasari et al, 2010</td>
<td>N = 38 with AD</td>
<td>RCT</td>
<td>2 h/wk (three 40-min sessions) × 8 wk</td>
<td>Targeted</td>
<td>Immediate JA intervention: instructing caregiver–child dyad during play routines; combined developmental and ABA approach; laboratory setting</td>
<td>At 8 wk, significant (P &lt; .00) between-group differences in level of joint engagement, child responsiveness to JA, and diversity of functional play acts (generally large effect sizes)</td>
<td>Caregiver mediated</td>
<td>Concurrent early intervention (9–40 h/wk) received by both groups (no differences in dose or type)</td>
<td>Moderate/high</td>
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<tr>
<td>Aged 21–36 mo (mean: 30.8); 29 boys</td>
<td>Delayed JA intervention (wait-listed group)</td>
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13 Small effect sizes for other parent–child interaction measures (child initiations with parent, parent–child shared attention)
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<tbody>
<tr>
<td>Oosterling et al,21 2010</td>
<td>N = 75 with ASD</td>
<td>RCT</td>
<td>Year 1: Group sessions 2 h/wk × 4 wk, then home visits 3 h/wk every 6 wk</td>
<td>Targeted Parent training by psychologists or sociotherapists (nonintensive, home-based, called &quot;focus parent training&quot;) plus care as usual</td>
<td>After 12 mo</td>
<td>Parents as everyday therapists</td>
<td>Modeled on the intervention of Drew et al,37 2002 (see below)</td>
<td>Flawed randomization of first 26 participants</td>
<td>Moderate to low/very low</td>
</tr>
<tr>
<td>Aged 12–24 mo (mean: 34.4 mo); 52 boys</td>
<td>Year 2: Home visits every 3 mo plus plenary sessions every 6 mo</td>
<td>Care as usual</td>
<td>No between-group differences in language development, global clinical development, or mediating outcomes (ie, child engagement, early precursors of social communication, parental skills)</td>
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<tr>
<td>Zachor and Ben-Itzchak,22 2010</td>
<td>N = 78 with ASD</td>
<td>Quasi-experimental</td>
<td>20 h/wk × 1 y</td>
<td>Comprehensive ABA-based intervention: 1:1,a child-centered; part of community center–based ASD-specific preschool program (40 h/wk)</td>
<td>NS between-group differences in change in ASD diagnostic classification, cognitive abilities, or adaptive skills</td>
<td>Stronger parent involvement in eclectic group</td>
<td>Groups not randomly assigned</td>
<td>Moderate</td>
<td>Weak</td>
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<tr>
<td>Aged 15–35 mo (mean: 25.4); 71 boys</td>
<td>19 h/wk × 1 y</td>
<td>ED: mix of developmental, DIR, and TEACCH; 75a, part of same preschool program (40 h/wk)</td>
<td>In subgroup with less severe baseline ASD symptoms, eclectic &gt;ABA in adaptive skills</td>
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<tr>
<td>Ben-Itzchak and Zachor,23 2009</td>
<td>N = 68 with AD</td>
<td>Open</td>
<td>35 h/wk × 1 y</td>
<td>Comprehensive ABA-based early intervention as a part of center-based autism-specific preschool; 1:1a</td>
<td>NS effect of type of intervention on change in autism severity (≈20% in each group changed diagnostic classification at 1 y)</td>
<td>Implemented by therapists and special education teachers</td>
<td></td>
<td>Moderate</td>
<td>Strong</td>
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<td>Reference</td>
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<td>Eikeseth et al.24</td>
<td>20</td>
<td>Aged 18–35 mo (mean: 25.4 mo); 62 boys</td>
<td>Open</td>
<td>Range of supervision intensity: 2.9–7.8 h/month (M: 5.2)</td>
<td>Comprehensive EIBI (UCLA/Lovaas model): home-based, 1:1, mean: 342 h/wk × 50 wk, parent-managed service</td>
<td>Intensity of supervision significantly (P &lt; .05) correlated with changes in IQ and visual-spatial IQ after 14 mo</td>
<td>Implemented by tutors</td>
<td>3 children excluded from data analysis (2 withdrew from study; 1 required increased supervision)</td>
<td>Very low/low</td>
</tr>
<tr>
<td>Ben-Itzchak and Zachor25</td>
<td>25</td>
<td>Aged 28–42 mo (mean: 34.9 mo)</td>
<td>Open</td>
<td>≥35 h/wk × 1 y</td>
<td>Intensive ABA intervention: center-based, 1:1, addressing developmental and behavioral areas</td>
<td>Significant (P &lt; .001) improvements after 1 y in imitation, receptive/expressive language, nonverbal communication, play skills, and stereotyped behaviors</td>
<td>Implemented by therapists</td>
<td>No control group</td>
<td>Low/moderate</td>
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*GRADE: Quality of Evidence 13, Recommendation 13*
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<tbody>
<tr>
<td>Goin-Kochel et al, 2007</td>
<td>29</td>
<td>Aged 29.6–61.4 mo (mean: 45.7 mo); 27 boys</td>
<td>Open</td>
<td>&gt;30 h/wk x 12–18 mo</td>
<td>Comprehensive</td>
<td>EIBI: ASD-specific preschool program in private school setting; ABA-based (ABLLS®) curriculum; 1:1 plus small groups</td>
<td>Significant group progress over time across multiple skills (P &lt; .001 for all ABLLS domains)</td>
<td>Parents “required” to provide EIBI at home, 10 h/wk, to supplement school-based intervention</td>
<td>No control group</td>
<td>Low</td>
<td>Weak</td>
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<tr>
<td>Magiati et al, 2007</td>
<td>44</td>
<td>Aged 25–54 mo (mean: 38.0, 42.5); 59 boys</td>
<td>Quasi-experimental</td>
<td>18–40 h/wk x 2 y (M, 55.2 at end of 2 y)</td>
<td>Comprehensive</td>
<td>EIBI in community setting: home based; 1:1; DTI and, in 2 families, verbal behavior</td>
<td>NS group differences in cognitive ability, language, play skills, or ASD severity at 2 y</td>
<td>Moderate to large effect sizes for adaptive behaviors; moderate effect size for ASD severity</td>
<td>Access to archival school data only; (not known whether other interventions were received)</td>
<td>Groups not randomly assigned</td>
<td>Low/moderate</td>
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<tr>
<td>Reed et al, 2007</td>
<td>27</td>
<td>Aged 31–48 mo (mean: 42.9, 40.8 mo); all boys</td>
<td>Quasi-experimental</td>
<td>20–40 h/wk (M, 50.4) x 9–10 mo</td>
<td>Comprehensive</td>
<td>Home-based, high-intensity ABA programs, mostly 1:1 and in natural settings: UCLA/Lovaas model</td>
<td>Significant (P &lt; .01) between-group differences in educational functioning</td>
<td>Some involvement by family members</td>
<td>Groups not randomly assigned</td>
<td>Low/moderate</td>
<td>Weak</td>
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<tr>
<td>Remington et al., 2007</td>
<td>44</td>
<td>Aged 30–42 mo (mean: 35.7, 55.4 mo)</td>
<td>Quasi-experimental</td>
<td>18.4–34.0 h/wk (mean: 26.6) × 2 y</td>
<td>Comprehensive EIBI: ABA-based, home setting, delivered by multiple service providers; plus &quot;usual&quot; treatments</td>
<td>Significant main effects of group for IQ, daily living skills, and motor skills; significant differences in language abilities at 1 and 2 y favoring EIBI</td>
<td>Moderate</td>
<td>Strong</td>
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<td>11–20 h/wk (mean: 12.6) × 9–10 mo</td>
<td>Verbal behavior focusing on developing verbal responses; Home-based, low-intensity, generic ABA program</td>
<td>Small effect sizes for all groups in adaptive behavior of 3 high-intensity programs; CABAS had best effect sizes</td>
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<tr>
<td>Zachor et al., 2007</td>
<td>39</td>
<td>Aged 30–42 mo (mean: 35.7, 58.4 mo)</td>
<td>Quasi-experimental</td>
<td>35 h/wk × 1 y</td>
<td>Comprehensive ABA-based early intensive intervention: center-based, 1:1, DTT, naturalistic techniques</td>
<td>ABA &gt; ED in improvements in language and communication (P &lt; .01) and reciprocal social interaction (P = .07); only ABA showed significant improvement in former domain; ABA had larger effect size in latter</td>
<td>Implemented by therapists</td>
<td>Low</td>
<td>Weak</td>
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<tr>
<td>Cohen et al, 2006</td>
<td>N = 42 with ASD</td>
<td>Quasi-experimental 35–40 h/wk × 47 wk/y × 5 y²</td>
<td>Comprehensive EIBI (UCLA/Lovaas model): community based, 1:1 home instruction, BT, plus classroom-based regular education preschool</td>
<td>Implemented by tutors</td>
<td>Groups not randomly assigned</td>
<td>Very low/low</td>
<td>Weak</td>
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<tr>
<td>Kasari et al, 2006</td>
<td>N = 58 with AD</td>
<td>RCT</td>
<td>2.5 h/wk × 5–6 wk</td>
<td>Targeted JA intervention: child-centered ABA and milieu teaching strategies added to EIP; laboratory setting</td>
<td>Children directly taught by trained interventionists</td>
<td>At year 3, EIBI children in regular education (6 without support) vs 1 of 21 in comparison group</td>
<td>Treatment fidelity not assessable in comparison group</td>
<td>Moderate/high</td>
<td>Strong</td>
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<tr>
<td>Kasari et al, 2008</td>
<td>Aged 5–4 y (mean: 43.2, 42.7, 41.9 mo); 46 boys</td>
<td>RCT</td>
<td>2.5 h/wk × 5–6 wk</td>
<td>SP intervention using same strategies, added to same EIP; laboratory setting</td>
<td>JA skills in JA group and diversity and sophistication of play in SP group compared with controls (large effect sizes)</td>
<td>Control group then received more hours of intervention services than former JA (P &lt; .05) and SP (P &lt; .01) groups</td>
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1 GRADE: **Strength** of evidence: low to high.
2 GRADE: **Recommendation** regarding intervention: weak to strong.
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<td>ZWAIGENBAUM et al</td>
<td>EIP: 30 h/wk × 5–6 wk</td>
<td>Control group: Same EIP without JA or SP intervention: hospital day-treatment program for children with developmental disabilities and/or behavioral disorders; 1:1 or 1:2 ABA-based techniques; adult-centered, response-oriented approach to teaching</td>
<td>Acquired skills generalized to play with mothers (large effect sizes for JA and SP)</td>
<td>Some general effects of therapy (JA, functional play skills) in JA and SP groups</td>
<td>At 12-mo follow-up: Significantly (P &lt; .01) greater growth in expressive language for JA and SP (moderate effect sizes for JA and SP versus control)</td>
<td>Children with lowest language levels pretreatment had significantly (P &lt; .001) better language outcomes with JA than with SP or EIP (moderate to large effect sizes for JA)</td>
<td>JA and SP groups continued to show growth and generalization in skills and outperform control group</td>
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<td>Reference</td>
<td>N (Chronological Age, Gender)</td>
<td>Design</td>
<td>Dose</td>
<td>Treatment Content</td>
<td>Outcomes</td>
<td>Degree of Parental Involvement</td>
<td>Comments</td>
<td>GRADE Quality of Evidence</td>
<td>GRADE Recommendation</td>
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<td>Wetherby and Woods, 2006</td>
<td>N = 17 with ASD</td>
<td>Quasi-experimental</td>
<td>2 home visits/wk x 1 y</td>
<td>Targeted ESI: family training to follow child’s focus of attention and build child’s skills in daily routines (developmental approach, natural environment)</td>
<td>Significant improvements from baseline for ESI group in 11 of 13 social communication measures (large effect sizes for 12 CSBS DP behavioral sample measures, moderate effect size for 15th measure)</td>
<td>Implemented by parents</td>
<td>Not known whether groups were matched at baseline (age 2 y)</td>
<td>Very low/low</td>
<td>Weak</td>
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<td>Aged 12–24 mo (mean: 18.2 mo); 15 boys</td>
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<td>Plus 1 supervised parent–child play group (including TD children) per week x 9 wk x 1 y</td>
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<td>At age 3 y, ESI &gt; contrast group in social communication (large effect size for 8 of 13 CSBS DP measures)</td>
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<td>Actual intervention intensity not documented</td>
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<td></td>
<td>n = 18 with ASD</td>
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<td>Yoder and Stone, 2006</td>
<td>N = 36 with ASD</td>
<td>RCT</td>
<td>1 h/wk (three 20 min sessions) x 6 mo</td>
<td>Targeted University clinic–based PECS: 6 instructional phases conducted by speech-language pathologists</td>
<td>RPMT &gt; PECS in facilitating frequency of generalized IJA (in children with some pretreatment IJA) and generalized turn taking (large and moderately large effect sizes, respectively)</td>
<td>Parent training (up to 15 h) to support intervention use outside clinic</td>
<td>Examiners conducting pre/post assessments not blinded to treatment status</td>
<td>Moderate/high</td>
<td>Weak</td>
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<td>Aged 25–36 mo (mean: 31.6 mo); 14 boys</td>
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<tr>
<td>Howard et al, 2005</td>
<td>N = 61 with ASD</td>
<td>Quasi-experimental</td>
<td>25–40 h/wk x 14 mo</td>
<td>Comprehensive EIIBI: 1:1, home, school, or community setting</td>
<td>EIIBI &gt; AP, significantly higher group mean scores for IQ, nonverbal language, overall communication, and social skills</td>
<td>Delivered by trained tutors</td>
<td>Groups not randomly assigned</td>
<td>Very low/moderate</td>
<td>Weak</td>
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<td>Reference</td>
<td>N, Chronological Age, Gender</td>
<td>Design</td>
<td>Dose</td>
<td>Treatment Content</td>
<td>Approach</td>
<td>Outcomes</td>
<td>Degree of Parental Involvement</td>
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<td>Aged &lt;48 mo (mean: 30.9, 37.4, 34.6 mo); 54 boys</td>
<td>25–30 h/wk × 14 mo</td>
<td>Intensive, eclectic autism-specific educational programming (AP): 1:1 or 2:1, public school classroom-based, including DT, PECS, and TEACCH</td>
<td>NS differences in group mean scores between AP and GP</td>
<td>Parents to implement programs outside of scheduled intervention hours</td>
<td>No direct group comparison; statistical analysis of group mean scores</td>
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<td>15 h/wk × 14 mo</td>
<td>Nonintensive generic educational programming (GP): 6:1, community based, mix of methods</td>
<td>↑ Learning rates at 14 mo (P ≤ .05) for EIBI versus other 2 groups in all domains except motor skills (normal or above-normal rates, especially in acquisition of language skills)</td>
<td>Many techniques not operationally defined</td>
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<td>Drew et al., 2002</td>
<td>N = 24 with AD</td>
<td>RCT</td>
<td>3 h/wk every 6 wk × 12 mo</td>
<td>Targeted Parent training (home-based) that focused on joint attention skills; plus available community services</td>
<td>NS group differences in child language development after 12 mo</td>
<td>Parent mediated</td>
<td>Groups not matched on baseline nonverbal IQ</td>
<td>Very low/low/moderate</td>
<td>Weak/moderate</td>
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<td>Aged &lt;24 mo (mean: 22.5 mo); 19 boys</td>
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<td>Reference</td>
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<td>Design</td>
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<td>Smith et al, 2000</td>
<td>N = 28 with ASD</td>
<td>RCT</td>
<td>30 h/wk × 2–3 y (decreasing in later years with progress by child)</td>
<td>Comprehensive EIBI (UCLA/Lovaas model): home-based 1:1, then shifting to classroom setting, ABA-based</td>
<td>Significant (P &lt; 0.05) between group differences at age 7–8 y in IQ, visual spatial skills, and language development favoring EIBI</td>
<td>Intensive treatment implemented by therapists</td>
<td>Lacked standardized diagnostic instrument</td>
<td>Moderate/high</td>
<td>Strong</td>
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<td>Aged 18–42 mo (mean: 35.8, 36.1 mo), 23 boys</td>
<td>5 h/wk parent training × 3–9 mo plus 10–15 h/wk of special education for children</td>
<td>Parent training in same treatment approaches; plus special education classes for children</td>
<td>No differences in adaptive functioning or behavior problems</td>
<td>In both groups, parents asked to provide 5 h/wk of intervention</td>
<td>Skewed distribution of scores precluded some statistical analyses</td>
<td>Improved school placement in intensive treatment group</td>
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**Notes:**
- ABLLS, Assessment of Basic Language and Learning Skills; AD, autistic disorder; ADOS, Autism Diagnostic Observation Schedule; ADOS-G, Autism Diagnostic Observation Schedule–Generic; ADOS-T, Autism Diagnostic Observation Schedule–Toddler Module; AEPS, Assessment, Evaluation, and Programming System for Infants and Children; AP, intensive eclectic autism-specific educational programming; CABAS, Complete Application of Behavior Analysis to Schools approach; CBBS, DP, Communication and Symbolic Behavior Scales Developmental Profile; DIR, Developmental, Individual Difference, Relationship; DTT, discrete trial training; ED, eclectic-developmental; EIBI, early intensive behavioral intervention; EIP, Early Intervention Program; ESAT, Early Screening of Autistic Traits questionnaire; ESI, Early Social Interaction Project; GP, general population; ITT, intention-to-treat; ITC, Infant/Toddler Checklist; IJA, initiating joint attention; JA, joint attention; PACT, Preschool Autism Communication Trial; PECS, Picture Exchange Communication System; RCT, randomized controlled trial; RIT, reciprocal imitation training; RJA, responding to joint attention; RPMT, Responsive Education and Prelinguistic Milieu Teaching; SP, symbolic play; STAT, Screening Tool for Autism in Two-Year-Olds; TD, typically developing; TEACCH, Treatment and Education of Autistic and Related Communication Handicapped Children; UCLA, University of California, Los Angeles.
- Child-to-teacher ratio.
- Dawson et al, 2010: Including speech, developmental preschool.
- Green et al, 2010: Treatment as usual included group-based autism psychoeducation, communication-focused intervention, Portage therapy, speech and language therapy, and for 1 child each in PACT group: home-based EIBI and Son-Rise therapy.
- Kasari et al, 2010: Concurrent early interventions involved mostly ABA/educational services and speech and occupational therapy; study investigators did not coordinate with providers of these services.
- Osterling et al, 2010: Care as usual, including speech and language therapy, motor therapy, music therapy, play therapy, and parent counseling.
- Remington et al, 2007: Treatment-as-usual interventions in both groups included PECS, TEOCH, speech therapy, dietary intervention, and prescription medications.
- Zachor et al, 2007: ED approach included speech and language, occupational, and music therapies, plus structured cognitive teaching (DIR, TEOCH, and ABA techniques).
- Cohen et al, 2006: 35 to 40 hours per week for children aged >3 years; 20 to 30 hours per week for children aged < 3 years.
- Drew et al, 2002: Children in control group received mix of speech and language therapy, occupational therapy, and preschool services. Within 5 mo of initial assessment, 3 children in control group started on intensive, home-based ABA interventions (UCLA/Lovaas model, 1.1, mean of 52.9 h/week for 12 months).
- Drew et al, 2002: Reflects different assessments of 3 reviewers.
Compared with early intervention models evaluated for preschool-aged children (aged 3–5 years), programs for children aged <3 years were more likely to use developmental approaches, more intensively involve parents, and target social communication. These studies varied in sample size and severity of diagnosis, dose (level of intensity/frequency of service delivery), duration, agent (parent, therapist, or a combination), and format of delivery (parent-managed/home-based and/or center-based in a clinic or school) of the intervention. Some interventions were comprehensive, defined as addressing multiple core ASD deficits, while others targeted specific areas of functioning. A word of caution is warranted when interpreting any 1 interventional study or model. In some cases, elements of a particular programmatic approach varied from study to study (eg, the addition of training in advanced social skills in 1 early intensive behavioral intervention program). Furthermore, reported group differences may not reflect the range of individual responses in any 1 study, and participants who demonstrated gains in some end points may have continued to show impairment in others.

Six randomized controlled trials were considered to produce strong recommendations and an assessment that the desirable effects of an intervention clearly outweighed the undesirable effects. Only 2 studies focused solely on children aged <3 years; 1 was related to a comprehensive treatment approach, and 1 was a targeted intervention program. The remaining 4 studies included preschool-aged children as well as some children aged <3 years or focused on developmental tasks of infancy. Two of these studies evaluated the same sample of children aged 3 or 4 years at the beginning of treatment.

To briefly summarize these 6 studies, both of the comprehensive intervention programs (Early Start Denver Model [ESDM] and the UCLA/Lovaas model) and the 4 targeted interventions (focusing on social communication or imitation skills) exhibited significantly improved outcomes relative to comparison groups after therapeutic durations of 8 weeks to 2 to 3 years. Several of the 6 studies reported effect sizes: large effect sizes after 6 and 8 weeks of therapy for increases in joint attention skills, a moderate effect size after 12 months for expressive language growth, and small effect sizes after 13 months for parent–child interaction measures. It is notable that targeted interventions generally focused on outcomes related to ASD-specific characteristics, whereas the comprehensive models included teaching to the core deficits but often did not measure changes in these core deficits (or obtained nonsignificant findings); they instead focused on gains in general functioning (eg, cognitive and/or adaptive skills). Two nonrandomized controlled studies were rated as producing strong recommendations: comprehensive applied behavior analysis (ABA)-type interventions were associated with significantly improved outcomes relative to the comparison group after 2 years (compared with publicly funded educational services) and with significantly improved outcomes in a subset of participants after 1 year (compared with an eclectic mix of treatments).

Although other studies included in the present review exhibited less than moderate quality of evidence and/or produced weak recommendations, it was agreed that the findings in these studies might nevertheless inform treatment options as well as future research. Specifically, there were studies rated as having a strong quality of evidence but equivocal findings. For example, a recent trial evaluated the ESDM in a brief format: 1 hour per week of parent training for 12 weeks, as opposed to the original ESDM, which involved 20 hours per week of therapist involvement plus additional parent-mediated intervention for 2 years. The study failed to detect improvements in parental intervention skill acquisition and child-related outcomes relative to community intervention controls.

Based on expert opinion that arose from the review and discussion of the existing evidence, members of the working group agreed on several summary statements intended to guide clinical practice and future research. Practice recommendations are highlighted in statements 1 through 4; consensus regarding future research directions is highlighted in statements 5 through 9. Statement 10 focuses on the importance of considering the potential impact of medical comorbidities on treatment and developmental outcomes.

**SUMMARY STATEMENTS**

**Statement 1:** Current best practices for interventions for children aged <3 years with suspected or confirmed ASD should include a combination of developmental and behavioral approaches and begin as early as possible.

Based on current outcome data, the working group supported the provision of interventions targeted to the specific deficits of ASD (eg, language skills, joint attention, emotional reciprocity) for children aged <3 years that integrate both behavioral and developmental approaches. Behavioral interventions are techniques based on behavioral analysis of antecedents and consequences of specific behaviors, and they use principles derived from experimental psychology research to systematically change behavior. Developmental models of intervention use developmental theory to design approaches to target ASD deficits.

Developmental approaches often
underlie community services, such as public school programs implemented by special education specialists and speech and language pathologists. However, the distinction between behavioral and developmental strategies may not be very helpful, as many intervention programs blend features of both approaches. The curricula of a behavioral intervention may be developmentally informed and based on developmental sequences, whereas a developmental program could use behavioral techniques to teach a curriculum.

Our analysis supports the effectiveness of integrated developmental and behavioral interventions, outside of the laboratory setting, in improving developmental quotients, adaptive functioning, and language skills.

In line with the American Academy of Pediatrics, the working group recommended initiating interventions as soon as a diagnosis of ASD is seriously considered or determined. Data available since 2001 support the fact that early intensive education and therapies can yield significantly improved developmental outcomes. In addition, it has been suggested that interventions initiated before 3 years of age may have a greater positive impact than those begun after the age of 5 years.

Statement 2: Current best practices for children aged <3 years with suspected or confirmed ASD should have active involvement of families and/or caregivers as part of the intervention.

There is a consensus that effective early intervention includes a family and/or caregiver component. For many intervention programs, this approach would mean parental involvement as a co-therapist, with appropriate supervision, training, and monitoring as part of the intervention. Specifically, parents should help set goals and priorities for their child’s treatment, identify and locate needed support for themselves, and teach or reinforce their child’s new skills at home and in the community. Active family involvement can have a positive impact on developmental outcomes. Parental or caregiver involvement increases the amount of intervention time delivered to the child inasmuch as children in this age range are likely to spend more time with their parents in their home and neighborhoods than in other settings. Furthermore, parents and caregivers can capitalize on teachable moments as they occur, provide learning opportunities during daily routines, and facilitate the generalization of learned skills across environments. Family involvement is also likely to be cost-effective and increases the sense of empowerment on the part of parents and caregivers. In the 2 comprehensive developmental/behavioral programs for which we have moderate or high evidence of effectiveness, parents were supported in complementing educators and therapists in the delivery of the interventions because of the importance of, and challenges inherent in, carrying over services and generalizing skills across multiple settings. Importantly, the concept of parental involvement is consistent with the recommended broader best practices that support working with young children in natural environments. Several parent-mediated interventions have shown positive parent and/or child outcomes. However, the extent to which these interventions are as effective as therapist-mediated interventions or are more effective when added into comprehensive child services, or with the combination of therapist plus parent mediated interventions, requires further study.

Statement 3: Interventions should enhance developmental progress and improve functioning related to both the core and associated features of ASD, including social communication, emotional/behavioral regulation, and adaptive behaviors.

Many behavioral interventions for ASD focus on cognitive, behavioral, and language outcomes, but interventions also need to address social communication challenges central to the diagnosis. Sensory dysregulation, challenging behaviors, and motor skills are also common in children with ASD and should be targeted by interventions when needed.

Despite an apparent lack of change on standardized measures of social communication symptoms in 2 randomized controlled trials, a growing body of research describes the beneficial effects early intervention has on the development of communication and social functioning. (This lack of change may reflect the utilization of symptom measures such as the Autism Diagnostic Observation Schedule, which, as a diagnostic tool, was designed to be relatively stable; measures specifically designed and validated as being sensitive to change are needed.) Specifically, targeted interventions have been associated with gains in imitation, joint attention, social engagement, other social communication measures, and functional and symbolic play.

Impaired effortful control (i.e., a reduced ability to regulate attention, emotions, and behavior to achieve goals) has been reported in children with ASD as early as at 24 months of age. Interventions dealing with attention regulation in young children with ASD have not yet been reported, but in typically developing children, short-term training has improved attention control measures associated with effortful
control. Comprehensive interventions that blend developmental and behavioral approaches have successfully improved adaptive functioning in many studies. Thus, future intervention studies should address and assess various developmental domains as intervention and outcome targets.

Statement 4: Intervention services should consider the sociocultural beliefs of the family and family dynamics and supports, as well as economic capability, in terms of both the delivery and assessment of factors that moderate outcomes.

Socioeconomic status, family characteristics, and cultural factors may present barriers to service provision. Families with lower socioeconomic status are likely to have less access to services. Because cultural values and differences can affect the goals and priorities of the family and may in some cases lead to misunderstandings, clinicians and other service providers should aim to understand the values, beliefs, and accompanying practices of families of differing cultures and assimilate that knowledge into their practice parameters as it relates to autism occurring in ethnically diverse populations. Culturally competent care extends beyond fluency in a non-English language. As a minimum, culturally appropriate program materials should be developed for families. In addition, training programs should be created that can help service providers learn how to promote culturally responsive assessment and intervention services.

Management of a child with ASD should focus on the family as well as on the child. Important considerations for the clinician include the well-being of each person in the family, the comfort and support of each family member, the lifestyle that has evolved around the child with ASD, and the unmet needs among family members or problem areas that might otherwise go unaddressed. Service providers can be of assistance by monitoring the physical and mental health of the family as well as that of the child with ASD. Finally, respect for the perceptions, priorities, and preferences of family members is an important “family-centered” tenet to bear in mind when working with children on the autism spectrum and their complex needs.

Statement 5: Intervention research should include socially and culturally diverse populations of participants and evaluate familial factors that may affect participation, acceptability, and outcomes of therapeutic approaches as well as willingness to participate in investigative studies.

Parents are expected to play a prominent role in supporting optimal development and thus intervention program delivery for their children, particularly at a very young age. An important focus of intervention research should therefore include factors such as cultural background and other family characteristics that may influence participation in treatment programs and interventional results. Due to attitudes concerning childhood rearing and independence, shame regarding developmental delays and ASD, or other societal and cultural beliefs, parents may be reluctant to enroll a child in a research study. Cumulatively, such decisions can diminish the generalizability and clinical applicability of reported interventions. In addition, when there is participation, cultural differences and language barriers might influence and moderate treatment effects.

In addition to any cultural issues, when parents are expected to be the therapeutic provider, assessment should focus on more than just fidelity of implementation and adherence to intervention goals. The quality of a parent’s involvement, consideration of a parent’s other responsibilities and roles, and potential family stressors arising from fulfilling their role in an intervention or from coping with care for a child with ASD warrant examination to determine whether moderators of treatment are present or are needed. Apart from any possible reluctance by families to participate in research, there is also a need for investigators to make a particular effort to recruit as culturally diverse a research sample as possible.

Statement 6: Future research should prioritize well-defined sampling strategies, rigorous investigative design, fidelity of implementation, and meaningful outcome measurements.

The methodologic rigor of intervention trials in ASD is improving, but continued attention to key aspects of research design is needed to further develop the evidence base for toddlers.

Future directions include identifying characteristics of children and families who would benefit most from particular interventions to support a more individualized approach, as well as systematically varying components of multifaceted intervention programs to identify critical ingredients. Thorough characterization of research participants would help to define the subset of children and families who most strongly benefit from particular intervention approaches. In addition, to avoid systematic bias from confounding factors, research participants should be randomly allocated to the treatment approaches that are being compared, and each treatment (including
community-based “as-usual” treatment) should be thoroughly described. Although the optimal study design to minimize bias in treatment research is a randomized controlled trial, it is acknowledged that contexts occur in which other methods may be appropriate. For example, to determine whether an intervention holds promise, it is important that intervention procedures are carefully tested for feasibility and acceptability. Moreover, single case designs, carefully implemented and with attention to appropriate measurement, may also be informative. Attention to and systematic evaluation of fidelity of implementation and selection of well-validated measures of key constructs (eg, joint attention, imitation, other indicators of age-appropriate social and communication skills and function) that are responsive to change are also essential.

**Statement 7:** Research is needed to determine the specific active components of effective interventions, including but not limited to the type of treatment provided, the agent implementing the intervention(s) (parent, therapist, teacher, or combination), consistency of service provision across environments and between providers, and duration of treatment and hours per week.

Information is lacking regarding the features of an intervention that drive its effectiveness, but progress is being made on identifying these active ingredients or mechanisms of change. Without appropriate study designs to carefully examine the effect of specific intervention strategies such as treatment type, dose, and agent, we may be unable to determine which of the potentially significant elements in an intervention model are responsible for change and for which subgroups. With such information, future intervention programs can be refined.

**Intensity of intervention**

The National Research Council has recommended a minimum intensity of 5 hours a day, 5 days a week, for interventions. However, some recent studies have suggested the possibility of positive outcomes with fewer hours of direct therapist involvement for young toddlers with ASD, particularly when parents are actively engaged in the treatment process. For example, gains in some social communication skills (eg, play, joint attention, imitation) were demonstrated in some studies when directly targeted in interventions of relatively low intensity (based on hours per week or length of treatment). Notably, the “real-life” intensity of the intervention may be influenced by the degree to which parents are implementing the strategies in natural routines throughout the day. The effectiveness of interventions is also likely to be influenced by whether training and ongoing supports allow parents to correctly implement the treatment strategies (ie, with fidelity to the treatment procedures as originally designed), as has been reported in the treatment of preschool-aged children with ASDs. In addition, other factors can affect the extent to which such interventions are effective, including age, degree of impairment, and the extent to which the child receives other services.

**Treatment content**

A recent study in toddlers with ASD has attempted to determine the additive value of joint attention, imitation, and affect on an intervention when applied within 2 developmental/behavioral toddler classroom environments. The investigators evaluated impact in 1 study group, and another group received the same overall comprehensive intervention but without the ingredient of interest. Few differences emerged in this study except for the apparent benefit of imitation in 1 group. Nonetheless, this research paradigm provides a possible model through which intervention research may be implemented. Similarly, other investigators have evaluated the additive effects of joint attention or play skills into an ABA program that did not include a focus on these developmental skills. Teaching these skills increased their spontaneous occurrence in generalized contexts and further predicted greater language outcomes compared with the children in the ABA program without a focus on play and joint attention.

Incorporating teaching targets of joint attention, play, and imitation are clearly indicated for early intervention programs for ASD. However, given the heterogeneity of the disorder, it will be critical to determine how treatment strategies can be most effectively tailored to the needs of subgroups of children with ASD who have particular clinical profiles.

**Statement 8:** Adopting a common set of research-validated core measures of ASD symptoms (including but not limited to cognitive function, communication, and adaptive behavior) that can be used across multiple sites will facilitate comparisons across studies of children with ASD aged <3 years.

The interpretation of study findings is often hampered when investigators use different variables, or measures, to report outcomes. A consistent set of core measures relevant to the specific intervention goal(s) of interest should be adopted for studies of toddlers with ASD as well as for older children. Outcome measures do not need to be identical across studies, but agreement on a subset of standardized instruments to use (which may assess
changes in cognitive function, core autism symptoms, and adaptive and language behavior) would facilitate future comparisons. Some early developmental skills could yield “early-read” measures that are important to later developmental outcomes. These early-read measures may include joint attention, shared affect, and imitation skills, with the expectation that these early developmental tasks may predict better functioning in later cognition, language, and adaptive behavior. Early-read measures may provide important information on the effectiveness of short-term interventions and may also offer information on active ingredients essential to include in comprehensive intervention programs. Additional measures related to the impact that having a child with ASD has on family life and parental stress would also be important.

**Statement 9: Future research should examine biological and behavioral heterogeneity as moderators of individual responses to interventions.**

In any sample population, positive responses to an intervention can range from dramatic to extremely limited. Factors that underlie such heterogeneity—possible moderators of individual responses—can include age at onset of intervention, patient characteristics (eg, baseline stage of development of cognitive function, language and preverbal skills, adaptive behavior, sociocultural characteristics), and symptom severity. As important, however, is the increasing appreciation that ASD is a heterogeneous disorder—etiologically, biologically, and clinically. Given this heterogeneity, it is highly likely that specific subsets of individuals with ASD may respond to specific interventions more effectively than to others, perhaps based on etiology and underlying biological factors alone. Thus, there is a critical need to begin to identify subtypes of individuals with ASD, to understand the cause of their disorder as well as the associated neurobiological mechanisms at work in each case, and to be able to offer more directed interventions depending on the biological subtype when available and present.

A number of genetic and neurobiological subgroups are already known to be associated with ASD. The most well-known groups are children with fragile X syndrome, tuberous sclerosis, and duplication 15q. Other genetic disorders have been identified as being associated with ASD features, and a growing number of candidate genes are being explored. For example, Campbell et al.66 reported that children with ASD and MET gene mutations were more likely to have gastrointestinal disorders, raising the possibility that medical comorbidities in children with ASD could index underlying genetic heterogeneity. It is thus important for future research to determine both biological and clinical subtypes within the autism spectrum that may ultimately affect the effectiveness of treatment and intervention.

To date, few studies have been designed or powered for analysis of heterogeneous effects.67 Treatment modifiers were recently identified in 2 studies based on appropriate study design and statistical analysis. In both studies, a measure developed to index the level of initial object exploration determined the extent to which a child would benefit more from 1 language-based intervention versus another or the extent to which children had better communication outcomes from a parent-mediated intervention.15 Object exploration can reflect a child’s flexibility in play and play level, both of which may influence later cognitive and language outcomes.59 Further studies like these are needed before we can make informed choices and personalize the treatment of each individual child.

**Statement 10: Intervention providers should consider medical disorders that may affect a child’s clinical presentation (especially behavior) and response to an intervention and should refer to appropriate health care providers as indicated.**

It has become increasingly evident in the ASD population that changes in behavior may be associated with an underlying medical condition.13 For example, clinical experience would suggest that a child with ASD exhibiting behavioral changes might be experiencing pain or discomfort owing to a medical problem such as otitis media, a dental abscess, or constipation. Frequently encountered medical factors in ASD include: seizures, particularly in children who also have severe intellectual disability, motor deficits, or a positive family history of epilepsy; other gastrointestinal symptoms; sleep disturbances affecting daytime functioning. The full effect of medical factors on the clinical presentation of children aged <3 years with ASD is not known, nor has the association between medical factors and maladaptive behaviors such as aggression and self-injury been well studied in general in ASD. Nevertheless, best practices would indicate that a patient with a potential medical comorbidity be referred to a medical specialist for appropriate evaluation, diagnosis, and management. It is important that future research address these and other potential medical factors, how they may be more reliably identified (especially in nonverbal or hypo-verbal ASD individuals), and what effect treatment of these conditions may have on behavior, developmental trajectory, and learning.

**ACKNOWLEDGMENTS**

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REFERENCES


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Drs Zwaigenbaum and Bauman initiated a literature review, co-chaired the meeting that generated the consensus recommendations outlined in this article, and drafted the initial manuscript; Drs Choueiri and Kasari co-chaired the working group that conducted the detailed literature review, generated initial recommendations that were discussed at the consensus meeting, and provided critical input to subsequent drafts of the manuscript; Drs Carter, Granpeesheh, Mailloux, Smith Roley, and Wagner were members of the working group that reviewed selected publications, contributed to initial recommendations that were reviewed at the consensus meeting, and critically reviewed the manuscript; Drs Fein, Pierce, Buie, Davis, Newschaffer, Robins, Wetherby, Stone, Yirmiya, Estes, Hansen, McPartland, and Natowicz contributed to the consensus meeting that formed the basis for the manuscript and critically reviewed the manuscript; and all authors approved the final manuscript as submitted.


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