Variables Affecting Outcome of Early Intervention in Autism Spectrum Disorder

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Abstract

Heterogeneity in autism spectrum disorder (ASD) is reflected in the child’s characteristics, including clinical variability in the severity of autism symptoms, cognitive ability, and language skills. Also, substantial individual differences are apparent about treatment outcomes. The effects of early intervention in ASD constitute one of the important questions ASD researchers face today. To what extent do factors such as child and family characteristics, intervention approach, and specific treatment components, influence outcome? This review focused on which preintervention factors better predicted outcome in each of the different outcome measures used most frequently in ASD research, including autism severity, cognitive ability, and adaptive behavior skills. For outcome in autism severity, predictors included child’s baseline age, cognitive ability, autism severity, and the type of treatment approach used. For cognitive gains, predictors included baseline autism severity, maternal and educational level, and the type and intensity of the treatment. For outcome in adaptive behavior skills, predictors included baseline cognitive ability, autism severity, maternal age, and the treatment approach and intensity. Future studies in this field should expand the scope of factors, look for more specific behaviors, and investigate the interplay between a child’s characteristics, familial factors, and various treatment aspects that might affect the outcome of the intervention.

Keywords

► autism spectrum disorder
► predictors
► early intervention
► autism severity
► cognitive gains
► adaptive behavior

Introduction

It is now well accepted that autism spectrum disorder (ASD) should be diagnosed as early as possible and that early intensive intervention is crucial for optimal outcome.1,2 ASD is considered a highly heterogeneous disorder. This heterogeneity is reflected in the child’s characteristics, including clinical variability in the severity of autism symptoms,3 cognitive ability,4 and language skills.5 Also, substantial individual differences are apparent about treatment outcomes.6 Biological findings support this heterogeneity in ASD as hundreds of genes7,8 and multiple neurobiological mechanisms9,10 have been found to be related to ASD.

The effects of early intervention in ASD constitute one of the important questions ASD researchers face today. To what extent do factors such as child and family characteristics, intervention approach, and specific treatment components influence the outcome? Previous studies have reported on various predictors of outcome in ASD, but there is no consensus among the study findings. Possible explanations for this variability may include the use of different outcome measures and the choice of different predictors in these studies.
This review will focus on which preintervention factors predict better outcome in each of the different outcome measures used most frequently in ASD research, including autism severity, cognitive ability, and adaptive behavior skills.

**Outcome in Autism Severity**

One of the most important goals in ASD intervention is to decrease the severity of ASD core symptoms. The improvement in sociocommunication skills and reduction in stereotypical behaviors might enable children to maximize their developmental potential. However, evidence regarding changes in autism severity as measured by standardized tests has been limited. One explanation for this scarcity is the relative difficulty of measuring subtle changes in autism severity using standardized tests. Few studies have investigated which factors might improve sociocommunication skills with intervention. Changes in autism severity using the algorithm scores of the Autism Diagnostic Observation Schedule (ADOS) were predicted by baseline cognitive ability and autism symptoms severity, baselines receptive language, receptive and expressive language score differences, and by baseline nonverbal IQ level using the Autism Behavior Checklist (ABC). Also, age at intake correlated positively with gains in ABC scores for children receiving early intensive behavioral intervention (EIBI).

Several studies have investigated the effect of the type of intervention used on outcome in autism severity. Zachor et al reported greater improvements in the ADOS communication domain only for a group receiving an applied behavior analysis (ABA)-based intervention, in comparison with a group receiving an eclectic developmental-based approach. Muratori et al reported a decrease in autism severity as measured by the ADOS algorithm after 6 months of community intervention, regardless of the type of intervention (either development-oriented or behavior-oriented). However, parental involvement was a mediator for this positive outcome. Kamio et al did not find any change in autism symptoms in either of the examined treatments, low-intensity ABA and treatment as usual (TAU), following 6 months of intervention.

**Outcome in Cognitive Ability**

Most of the early intervention outcome studies investigated cognitive outcome. Also, several meta-analysis reviews described in great detail the conclusions of the reviewed studies. Also, more recent original studies have reported improvements in cognition with intervention as well. Of the child characteristics, autism severity and child’s age best predicted cognitive gains. Less severe autism symptoms and a younger age at the start of intervention were associated with better outcomes.

Ben Itzchak and Zachor reported familial factors, including maternal age and educational attainment. Older maternal age and higher maternal education level predicted greater cognitive gains with intervention.

Most of the studies that examined various intervention types found that children who received EIBI in comparison to a different approach or TAU showed better improvements in cognitive ability, both in meta-analyses and in original studies. A study that compared the Early Start Denver Model (ESDM), a developmental-behavioral approach, to a community-based program reported significant cognitive gains for the ESDM group. Several studies did not find a major difference in cognitive outcome between the examined treatment approaches. Using a behavioral model intervention, Hayward et al did not find differences between clinic-directed treatments and parent-directed treatments.

Several meta-analyses found that the intensity of the intervention was associated with greater improvement in cognitive ability, while Virués-Ortega did not.

**Outcome in Adaptive Skills**

One of the most important and frequently used measures of intervention effectiveness is gains in adaptive skills, usually assessed by the Vineland Adaptive Behavior Scale (VABS). This measure might best represent the child’s biological competence, difficulties, and learning abilities during the time of the intervention. Gains in adaptive skills reflect the ability to generalize skills that are addressed in the early intervention to the “real world.” Several studies have examined predictors for better gains in adaptive skills as a result of the intervention. Of the various child characteristics, cognitive ability was found to better predict gains in adaptive behavior. Hayward et al reported that only visual-spatial IQ predicted changes in VABS composite scores. Eldevik et al reported that IQ scores at intake correlated only with adaptive socialization change. Klintwall et al used data from 16 group outcome studies and reported that IQ-age equivalent at intake predicted adaptive behavior outcome.

Ben Itzchak and Zachor reported that the baseline verbal ability best-predicted outcome in adaptive skills after 1 year of intervention. More specifically, in children with severe autism symptoms at baseline, their verbal ability correlated with outcome. Baseline language ability predicted progress in adaptive communication skills. Specific aspects of neurocognitive abilities of learning, such as reward association, memory, and novelty preference appeared to be good predictors of outcome in both communication and socialization adaptive skills.

In a comparison study of young children with ASD receiving EIBI in a community-based preschool, only children with high cognitive scores (DQ > 70) had significant gains in adaptive skills, specifically in communication, daily living skills and socialization after 2 years of intervention, while children with lower cognitive scores (DQ < 70) maintained their VABS standard scores. The researchers concluded that only children with a higher cognitive level at baseline translated their acquired adaptive skills into better daily functioning.

The preintervention severity of ASD symptoms was associated with the magnitude of adaptive skills outcomes. Children with lower ADOS scores at baseline improved in communication, daily living skills (DLS) and socialization VABS scores more than children with higher ADOS scores. Milder diagnoses (Asperger or pervasive developmental disorder not otherwise specified [PDD-NOS]) were associated with better VABS communication, DLS, and socialization subdomain scores. One study used a different
approach for identifying factors that affect outcomes of interventions in different domains. The change in diagnosis classification based on the ADOS cut off scores that reflect improvement in autism severity was associated with better cognitive gains and better progress in adaptive skills in comparison with a group that remained stable in its autism classification.\textsuperscript{13}

As expected, several studies found that greater initial adaptive behavioral skills were associated with better adaptive skills acquisition in early interventions.\textsuperscript{21,22,44}

Of the treatment factors, the type of intervention was the main predictor for adaptive skills gains. Most comparative studies\textsuperscript{6,27,35,38} and several meta-analyses\textsuperscript{16,30,45} reported an improved VABS composite score or greater subdomain scores in groups receiving EIBI in comparison to community or TAU groups. Dawson et al reported that children who received ESDM intervention showed stable VABS scores, while children who received community-based treatment had lower VABS scores after 2 years of intervention.\textsuperscript{32}

However, several studies reported that while all the treatment groups had improved adaptive skills, no significant adaptive skills differences were noted between groups receiving EIBI and other approaches.\textsuperscript{23,33,34,41}

Regarding the role of the intensity of treatment, two meta-analysis studies reported that the intensity of the intervention predicted gains in adaptive behavior.\textsuperscript{21,22} However, Virués-Ortega,\textsuperscript{23} did not find an association between the intensity of intervention and progress in adaptive skills.

Of the familial factors, maternal age but not maternal education predicted better gains in adaptive behavior. Older maternal age was associated with better adaptive skills outcomes.\textsuperscript{36} Two meta-analysis articles emphasized the contribution of parent training and parent involvement in better outcomes in adaptive skills.\textsuperscript{28,43}

Predictors of outcome of early intervention in ASD in the different domains are shown in Table 1. Of the child’s characteristics at baseline, better cognitive and verbal abilities were most commonly associated with a greater reduction in autism severity and better acquisition of adaptive skills. The significance of baseline autism severity as a predictor of outcome was less investigated. However, less severe autism symptoms at baseline resulted in better cognitive and adaptive skills gains with intervention. Only a few studies on early intervention reported that younger age was related to better cognitive gains and more significant reduction in autism severity. Important factors affecting the outcome of early intervention relate to the type and intensity of the intervention. Interventions that included behavioral and developmental components showed an advantage over community or treatment as usual interventions. The more intensive intervention resulted in better cognitive gains and a greater reduction in autism symptoms. The impact of familial factors on outcome of the intervention is less known, as there is a paucity of studies that have examined their effects. However, older maternal age predicted better cognitive gains and adaptive skills, while higher educational attainment predicted only better cognitive gains.

Revealing factors that explain the variability in outcomes in different domains is highly important for clinicians and may help them evaluate the child’s prognosis with intervention. This understanding can direct professionals in the ASD intervention field to better plan treatment based on realistic expectations. The research on predictors may help subtype ASD based on the response to intervention and may shed light on neurobiological and environmental aspects of ASD.

Future studies in this field should expand the scope of factors that might affect the outcome of intervention beyond the reviewed predictors. Specifically, studies on familial factors are very limited, and variables such as familial stress, the role of siblings, and familial status should be investigated.\textsuperscript{46} Also, until now studies have looked for general predictors, such as general cognitive abilities and autism severity. More specific behaviors that make up these measures might provide stronger predictors. For example, specific subtests of different cognitive domains (e.g., receptive language, visual reception) and specific social-communication impairments for autism severity (e.g., the deficit in eye contact or joint attention), can be further investigated as predictors. Not only individual factors can predict outcome; a better understanding of the

Table 1 Summary of positive predictors of intervention outcomes

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Child’s characteristics</th>
<th>Familial factors</th>
<th>Intervention</th>
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<tbody>
<tr>
<td><strong>Outcomes</strong></td>
<td></td>
<td></td>
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<tr>
<td>Autism severity</td>
<td>b. Cognitive ability\textsuperscript{12}; b. autism severity\textsuperscript{12}; b. receptive language\textsuperscript{13}; receptive and expressive score differences\textsuperscript{14}; b. nonverbal IQ\textsuperscript{15}; age\textsuperscript{16}</td>
<td></td>
<td>ABA &gt; eclectic developmental\textsuperscript{12}</td>
</tr>
<tr>
<td>Cognitive gains</td>
<td>Autism severity\textsuperscript{31,36}; age\textsuperscript{36}</td>
<td>Maternal age\textsuperscript{36}; maternal education\textsuperscript{36}</td>
<td>EIBI &gt; TAU\textsuperscript{16,20,25,30,35,37}; ESDM &gt; community\textsuperscript{32}; intensity\textsuperscript{21,22,23}</td>
</tr>
<tr>
<td>Adaptive behavior</td>
<td>Cognitive ability\textsuperscript{16,35,36,41,43}; visual spatial IQ\textsuperscript{34}; verbal ability\textsuperscript{15,36}; autism severity\textsuperscript{13,15,16,33}; b. adaptive skills\textsuperscript{21,22,44}; neurocognitive abilities\textsuperscript{42}</td>
<td>Maternal age\textsuperscript{36}</td>
<td>EIBI &gt; TAU\textsuperscript{6,16,27,30,35,38,45}; developmental &gt; Lovaas treatment\textsuperscript{46}; intensity\textsuperscript{21,22}</td>
</tr>
</tbody>
</table>

Abbreviations: ABA, applied behavioral analysis; b, baseline; EIBI, early intensive behavioral intervention; ESDM, early start Denver model; TAU, treatment as usual.
complexity and the variability seen in early intervention outcome should take into consideration the interplay of the different factors, including a child’s characteristics, familial factors, and various treatment aspects.

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References

38. Peters-Scheffer N, Didden R, Mulders M, Kozlilus H. Low intensity behavioral treatment supplementing preschool services for