CRD summary
This review concluded that Lovaas may be more effective than special education in improving some core features of
autism spectrum disorders, but clinical management should be based on an individual basis. This was a generally well-
conducted review, but given the limitations with the studies included in the review, it is difficult to confirm the
reliability of the authors’ conclusions.

Authors' objectives
To assess the effectiveness of behavioural and developmental interventions for improving symptoms associated with
autism spectrum disorders (ASD).

Searching
MEDLINE, EMBASE, CINAHL, PsycINFO, BIOSIS Previews, Web of Science and Cochrane Central Register of
Controlled Trials (CENTRAL) were among 22 electronic databases searched up to May 2007 for articles in English.
The search strategy was available online. Reference lists of identified studies, journal articles, databases of theses and
dissertations, and textbooks were searched. Experts in the field were contacted for additional studies.

Study selection
Randomised controlled trials (RCTs), controlled clinical trials (CCTs) and observational studies that assessed the effects
of a behavioural or developmental intervention in individuals with autism spectrum disorders were eligible for
inclusion. Individuals with dual diagnoses (such as any autism spectrum disorders plus attention deficit/hyperactivity
disorder, obsessive compulsive disorder or learning difficulties) were considered for inclusion. The primary outcome of
interest was the change in core features of autism spectrum disorders according to the Diagnostic and Statistical Manual
of Mental Disorders criteria (for example, communication and reciprocal social interaction). Secondary outcomes
included changes in various behaviours (such as developmental or cognitive changes and family-related outcomes).

Most included studies were of children less than six years of age, but some studies were of school age children,
adolescents or adults. Most studies did not report severity of autism spectrum disorders; where reported, most
participants were classed as having moderate or severe symptoms of autism spectrum disorders, with conditions
described as autistic disorder. Other conditions were described as Asperger's syndrome, high-functioning autism,
ataypical autism, not yet diagnosed autism or other.

Included studies assessed eight types of intervention: applied behaviour analysis; communication-focused interventions;
contemporary applied behaviour analysis; developmental approaches; environmental modification programs; integrative
programs; sensory motor interventions; and social skills development interventions.

One reviewer screened the relevant studies and at least two reviewers independently assessed relevant articles for
inclusion.

Assessment of study quality
Two reviewers independently assessed methodological quality of included studies according to previously published
criteria. Criteria for clinical studies included items on randomisation, allocation concealment, blinding and dropouts and
withdrawals. Criteria for observational studies included items on: methods of selection; ascertainment of outcome and
exposure; and handling of confounders in the design or analysis. Discrepancies were resolved by consensus.

Data extraction
One reviewer extracted endpoint data or change from baseline to endpoint data to calculate the mean differences and
their 95% confidence intervals (CIs). A second reviewer checked the data extraction for accuracy. Discrepancies were
resolved by consensus.

Methods of synthesis
Where two or more trials assessed the same intervention, used similar comparison groups or had data for common outcomes of interest, data were pooled using a random-effects model grouped by intervention type (as described in the review) and study design. Weighted mean differences (WMDs) and 95% CIs were calculated for studies that reported the same outcome measure. Otherwise, standardised mean differences (SMDs) and 95% CIs were calculated using Hedges g. Heterogeneity was assessed using the $\chi^2$ and $I^2$ tests. Where pooling of data was not possible, results were reported as a narrative synthesis and in tables.

Results of the review
One hundred and one studies were included in the review (n reported as 2,566). The number of patients per treatment group ranged from two to 60. Only 13 studies (six RCTs, five CCTs and two observational studies) were included in the meta-analyses. It was difficult to calculate the number of participants included in the meta-analyses as the references referred to in the text did not reflect those stated in the tables. Overall, the quality of the studies was reported to be modest. Only a small percentage of studies protected against selection bias and only half of the studies reported blinding of outcome assessors.

Applied Behaviour Analysis (one RCT, four CCTs):

The effects of Lovaas training were statistically significantly greater compared to special education for the following outcomes (three CCTs): adaptive behaviour (WMD 11.8, 95% CI 6.94 to 16.67); communication and interaction (WMD 16.63, 95% CI 11.25 to 22.01); comprehensive language (WMD 12.84, 95% CI 6.38 to 19.30); daily living skills (WMD 5.61, 95% CI 0.54 to 10.67); expressive language (WMD 15.05, 95% CI 6.19 to 23.90); overall intellectual functioning (SMD 0.95, 95% CI 0.44 to 1.46); and socialisation (WMD 9.17, 95% CI 2.16 to 16.19). The effects on daily living skills were not clinically significant and were borderline clinically significant for socialisation.

High-intensity Lovaas therapy was statistically significantly more effective than low-intensity therapy on intellectual functioning (SMD 0.92, 95% CI 0.61 to 1.24; reported as two retrospective cohort studies).

Developmental Approaches (two RCTs):

Statistically significant differences were reported for developmental approaches based on imitative interaction compared to contingency interaction in terms of time spent in stereotyped behaviour (WMD -0.40, 95% CI -0.73 to -0.07) and time spent in distal social behaviour (WMD 2.85, 95% CI 0.99 to 4.71). These differences were not clinically significant.

No statistically significant results were reported for the following comparisons: Lovaas training versus special education on measures of non-verbal intellectual functioning; Lovaas training versus developmental individual-difference relationship-based intervention on measures of communication skills; computer assisted instruction versus no treatment on measures of facial expression recognition; or TEACCH (Treatment and Education of Autistic and related Communication handicapped CHildren) versus standard care on measures of imitation skill and eye-hand integration.

There was no evidence of statistical heterogeneity for any of the meta-analyses. A narrative synthesis of studies not included in the meta-analyses was reported in the review.

Authors’ conclusions
The evidence suggested that Lovaas training was more effective than special education in improving some of the core features of autism spectrum disorders, but this was based on weak evidence. As no definitive behavioural or developmental intervention had been shown to improve all symptoms of individuals with autism spectrum disorder, clinical management should be based on individual needs and availability of resources.

CRD commentary
The review question was clear. Appropriate inclusion criteria were stated for participants, interventions and outcomes. Broad inclusion criteria were stated for study design. An extensive literature search used various appropriate sources.
and included searches for unpublished data, which reduced the possibility that potentially relevant papers were missed. The search was restricted by language, which meant that language bias could not be ruled out; the authors acknowledged this possibility. Assessment of publication bias was not undertaken due to small sample sizes. Validity was assessed using a reliable tool, but the quality of the studies was reportedly not very high and the effect of quality on the results was not investigated. The process for each stage of the review was reported, which minimised risks of reviewer error and bias. Appropriate methods were used to combine results and assess for statistical heterogeneity. The authors highlighted a number of limitations with the included studies, such as potential clinical and methodological heterogeneity, potential bias and small sample sizes. In general, this was a well-conducted review. However, there were discrepancies between the study references reported in the text and those reported in the tables and so it was not possible to identify the correct studies to confirm the results for both the narrative synthesis and the meta-analyses. Given the generally low quality of the studies and the limitations with the included studies, it is difficult to confirm the reliability of the authors' conclusions.

**Implications of the review for practice and research**

**Practice:** The authors stated that given the difficulties regarding the interpretation and generalisation of the results, treatment choices may need to be tailored to the individual child and symptoms to take into consideration the wellbeing of the child and family.

**Research:** The authors stated that well-conducted RCTs needed to be replicated to clarify the use of Lovaas intervention and to determine the effect of treatment intensity on the outcomes of children with autism spectrum disorders. Further consideration should be given to the longer term effects of behavioural and developmental interventions and the impact of these interventions on family outcomes (such as functioning and quality of life). Future research should be interpreted in the light of the study populations, characteristics and application of the interventions, outcomes examined and methodological quality. Studies should use validated outcome measures and consider using standard care as the control.

**Funding**
The Alberta Centre for Child, Family and Community Research (Grant #G299000474).

**Bibliographic details**

**PubMedID**
19015734

**DOI**
10.1371/journal.pone.0003755

**Original Paper URL**
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0003755

**Other URL**
http://ukpmc.ac.uk/articlerender.cgi?tool=pubmed&amp;pubmedid=19015734

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Adolescent; Autistic Disorder /therapy; Behavior; Child; Child, Preschool; Clinical Trials as Topic; Communication; Early Intervention (Education) /methods; Education, Special; Humans; Infant; Language Therapy /methods; Outcome Assessment (Health Care); Psychotherapy /methods; Research Design

**AccessionNumber**
12009101694

Date bibliographic record published
07/04/2009

Date abstract record published
10/02/2010

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.