

A New Zealand
Guidelines Group
Systematic Review
19 December 2008

THE EFFECTIVENESS OF APPLIED BEHAVIOUR ANALYSIS INTERVENTIONS FOR PEOPLE WITH AUTISM SPECTRUM DISORDER

Report to the New Zealand Ministry of Education



PRINCIPAL AUTHORS

Marita Broadstock
Anne Lethaby

ACKNOWLEDGEMENTS

Mary Newman (Information Specialist, contracted from the Wellington Medical Library, University of Otago) developed the search strategy, undertook the search and coordinated retrieval of documents.

NZGG acknowledges and thanks Professor Jeffrey Sigafoos (College of Education, Victoria University of Wellington) who was contracted to act as expert consultant throughout the review. Professor Sigafoos advised on the search strategy, assisted in providing advice about included and excluded interventions and provided feedback to a late draft of this report.

We thank the following researchers who answered specific queries during the course of the review: Dr Sandra Calvert, Professor Susan Harris, Professor Rod Jackson, Dr Lynne Logan, Professor Scott McConnell, Professor Geraldine Macdonald, Dr Philip Reed.

We acknowledge the peer review of NZGG Research Services Manager, Dr Jessica Berentson-Shaw, and two anonymous reviewers contracted by the Ministry of Education, to an earlier draft of this report.

The review was funded by New Zealand's Ministry of Education and Ministry of Health.

Please cite this report as:

New Zealand Guidelines Group. *The effectiveness of applied behaviour analysis interventions for people with autism spectrum disorder. Systematic Review*. Wellington; 2008.

TABLE OF CONTENTS

Table of contents.....	v
List of appendices	vi
List of tables	vii
List of abbreviations and acronyms	viii
Executive Summary	xii
background.....	xii
Objectives and research questions.....	xii
Review methods	xiii
KEY findings and Conclusions.....	xiv
Background	1
Autism spectrum disorder	1
Applied behaviour analysis	2
Scope of review	4
Objectives	5
Research question.....	5
Method	7
Searching	7
study selection criteria	8
Study selection	12
Appraisal methodology	13
Presentation of results	13
Data synthesis	14
Limitations of the review methodology.....	14
Results	17
Search results.....	17
Description of studies	17
study quality and Risk of bias	26
Effects of interventions	26
Discussion.....	35
Summary and conclusions.....	39
References.....	42

LIST OF APPENDICES

Appendix 1: Search strategies

Appendix 2: Excluded studies

Appendix 3: Included studies

Appendix 4: Evidence Tables

LIST OF TABLES

Table 1: Designations of levels of evidence for evaluating intervention studies.....	10
Table 2: Summary of participants, settings, interventions, comparisons and outcomes in included studies.....	19

LIST OF ABBREVIATIONS AND ACRONYMS

1. Miscellaneous terms

Abbreviation	Details
ABA	Applied behaviour analysis
ANAES	L'Agence Nationale d'Accreditation d'Evaluation en Sante
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
APP	Autism Preschool Program
AS	Asperger Syndrome
ASD	Autism spectrum disorder
BMJ	British Medical Journal
BP	Behavioural programme
CA	Chronological age
CABAS	Comprehensive Application of Behavioural Analysis to Schooling programme
CCW	Child care workers
cf	Compared to
chn	Children
CI	Confidence interval
CMA	Canadian Medical Association
DT	Direct teaching
DTT	Discrete Trial Training
DTG	Delayed treatment group
ECI	Eclectic Intervention
ECRI	Emergency Care Research Institute
EIBI	Early Intensive Behavioural Intervention
EIBI – H	Early Intensive Behavioural Intervention – implemented or directed at home
EFA	Experimental functional analysis
ESP	Educational software programme
FBA	Functional behaviour assessment
FCT	Functional communication training
GEP	Generic Educational Programming
hrs	Hours
HTA	Health technology assessment
IEP	Individualised Education Plan
IQ	Intelligence Quotient
ITG	Immediate treatment group
JA	Joint attention intervention
LEA	Local Education Authority (UK)
LEAP	Learning Experiences, an Alternative for Preschoolers and their parents
LGWG	Living Guideline Working Group
LS	Local services
M	Mean
MA	Mental age
MADSEC	Maine Administrators of Services for Children with Disabilities
MANOVA	Multivariate analysis of variance
MIBI	Minimal intensity behavioural intervention
MIECI	Minimal intensity eclectic intervention

Abbreviation	Details
MR	Mental retardation
Mth	Month
NAS	National Autistic Society
NHMRC	National Health and Medical Research Council (Australia)
NHS	National Health Service (UK)
no	number
NTG	No treatment group
NVIQ	Non verbal intelligence quotient
NZGG	New Zealand Guidelines Group
PA	Play activities
PCDI	Princeton Child Development Institute
PDD NOS	Pervasive Developmental Disorder – Not Otherwise Specified
PECS	Picture Exchange Communication System
PND	Percentage of non-overlapping data points
PT	Parent training
PZD	Percentage of zero data
P/wk	Per week
RCT	Randomised controlled trial
RFT	Request for tender
RPMT	Responsive Education and Prelinguistic Milieu Teaching
Rx	Treatment
SCED	Single case experimental design
SD	Standard deviation
SIGN	Scottish Intercollegiate Guidelines Network
SFPE	Semi structured free play with examiner
SPELL	Programme based on Structure, Positive Empathy, Low arousal, Links
SP	Symbolic play intervention
SR	Systematic review
SS	Social skills
TEACCH	Treatment and Education of Autistic and related Communication-handicapped Children
UC	Usual care
UCLA	University of California, Los Angeles
UCSF	University of California, San Francisco
vs	Versus
V(S)M	Video (self) modelling

2. Diagnostic and outcome tests and measures

Abbreviation	Details
ABLLS	Assessment of Basic Language and Learning Skills
ABC	Autism Behaviour Checklist
ACBC	Achenbach Child Behaviour Checklist
ADI (-R)	Autism Diagnostic Interview (- Revised)
ADOS	Autism Diagnostic Observation Schedule
ATRF	Achenbach Teacher Report Form
BAS	British Abilities Scales
BLLS	Basic Language and Learning Skills
BSID (-R)	Bayley Scales of Infant Development (-Revised)
CARS	Childhood Autism Rating Scales
CDI	MacArthur Communicative Development Inventory
CELF (-III)	Clinical Evaluation of Language Test Fundamentals (-III)
CIIS	Cattell Infant Intelligence Scale

Abbreviation	Details
CSBS DP	Communication and Symbolic Behaviour Scales – Developmental Profile
DAS	Differential Abilities Scale
DAYC	Developmental Assessment of Young Children
DDST (-II)	Denver Developmental Screening Test (II)
DP (-II)	Developmental Profile (-II)
DSM (-IV)	Diagnostic and Statistical Manual of Mental Disorders (-IV)
ECS	Early Communication Scales
EIDP	Early Intervention Developmental Profile
ELM	Early Learning Measure
EOWPVT	Expressive One-Word Picture Vocabulary Test
ESCS	Early Social Communication Scales
EVT	Expressive Vocabulary Test
GARS	Gilliam Autism Rating Scale
ICD (-10)	International Classification of Diseases (-10)
ITDA	Infant Toddler Developmental Assessment
Leiter (-R)	Leiter International Performance Scale (-Revised)
MPSMT	Merrill Palmer Scale of Mental Tests
MSEL	Mullen Scales of Early Learning
NVIQ	Non verbal intelligence quotient
PEP (-R)	PsychoEducational Profile (-Revised)
PIC	Personality Inventory for Children
PLS-3UK	Preschool Language Scales – 3 UK
PPVT	Peabody Picture Vocabulary Test
PSDP	Preschool Developmental Profile
PSI	Parent Stress Inventory
RDLS	Reynell Developmental Language Scales
REELS (-2)	Receptive-Expressive Emergent Language Scales (-Revised)
RIDES	Rockford Infant Development Evaluation Scales
RITLS	Rossetti Infant-Toddler Language Scale
ROWPVT	Receptive One-Word Picture Vocabulary Test
SBIS	Stanford Binet Intelligence Scale
SBPT	Stanford Binet Performance Test
SICD (-R)	Sequenced Inventory of Communication Development (-Revised)
SIOC	Social Interaction Observation Code
SPT (-II)	Symbolic Play Test (- Second Edition)
TAQ	Tre-add Autism Quiz
TOM	Theory of Mind test
VABS	Vineland Adaptive Behaviour Scales
WIAT	Wechsler Individualised Achievement Test
WISC (-R)	Wechsler Intelligence Scale for Children (-Revised)
WJTA (-III)	Woodcock-Johnson (III) Tests of Achievement
WPPSI (-R)	Wechsler Preschool and Primary School Intelligence Scales (-Revised)

3. Databases

Abbreviation	Details
AMED	Allied and Complementary Medicine Database
CCOHTA	Canadian Coordinating Office for Health Technology Assessment
CDSR	Cochrane Database of Systematic Reviews
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CRISP	Computer Retrieval of Information on Scientific Projects
DARE	Database of Abstracts of Reviews of Effects
EED	Economic Evaluation Database
Embase	Excerpta Medica Database
ERIC	Education Resources Information Centre
HSRPROJ	Health Services Research Projects in Progress
HSTA	Health Sciences and Technology Academy
HTA	Health Technology Assessment
ISTAHC	International Society of Technology Assessment in Health Care
Medline	Medical Literature Analysis and Retrieval System Online
PsycINFO	Psychology Information Database
PsycLit	Literature Reference for Psychology
TRIP	Turning Research Into Practice

EXECUTIVE SUMMARY

BACKGROUND

This systematic review considers the evidence for the effectiveness of interventions grounded in the principles of applied behaviour analysis for people with autism spectrum disorder.

The Ministry of Education and the Ministry of Health ('the Ministries') sponsored and funded the development of a New Zealand Guideline on Autism Spectrum Disorder (ASD), a draft of which was released in December 2006. In response to comments received during consultation, the Ministries put out an open Request for Tender (RFT) (Ministries of Health and Education 2007) to undertake independent, systematic reviews of published research on the effectiveness of applied behaviour analysis interventions (ABA) for people with ASD. Two review groups were contracted by the Ministry of Education to provide parallel reviews using different methodological approaches. The findings from both reviews will be considered by the ASD cross government Senior Officials Group and where they identify implications for the current Guideline on ASD, these will be considered by the ASD Living Guideline Working Group (LGWG).

OBJECTIVES AND RESEARCH QUESTIONS

The objective of the review is to consider the effectiveness of ABA-based interventions for people with ASD.

ABA-based interventions can be defined as 'those in which the principles of learning theory are applied in a systematic and measurable manner to increase, reduce, maintain and/or generalise target behaviours' (Ministries of Health and Education 2007). Well-established principles and techniques of ABA include (a) reinforcement, (b) shaping, (c) chaining, (d) fading, (e) response and stimulus prompting, (f) discrimination training, (g) programming, and (h) functional assessment.

The clinical questions identified in the RFT (Ministries of Health and Education 2007) were:

To what extent are interventions and strategies based on the principles of applied behaviour analysis effective in leading to the following outcomes for people with autism spectrum disorders:

- social development and relating to others
- development of cognitive (thinking) skills
- development of functional and spontaneous communication which is used in natural environments
- engagement and flexibility in developmentally appropriate tasks and play and later engagement in vocational activities
- development of fine and gross motor skills

- prevention of challenging behaviours and substitution with more appropriate and conventional behaviours
- development of independent organisational skills and other behaviours
- generalisation of abilities across multiple natural environments outside the treatment setting
- maintenance of effects after conclusion of intervention
- improvement in behaviours considered non-core ASD behaviours, such as sleep disturbance, self mutilation, aggression, attention and concentration problems.

REVIEW METHODS

A systematic method of literature searching, selection and appraisal was employed in the preparation of this report, consistent with New Zealand Guidelines Group review processes.

Systematic searches were undertaken in late June 2008 to identify relevant articles. The search was limited to articles published in the English language between 1998 and 2007, inclusive. Sources included six general bibliographic databases, 16 health technology assessment/guideline databases and citation searching from retrieved references. This was supplemented by potentially relevant references submitted to the Ministries as part of consultation regarding the draft ASD Guideline. Relevant publications referenced in material obtained in the course of our review on the topic were also identified.

Studies were **included** if they:

- were primary (original) group studies with a parallel control group or were secondary research (systematic reviews and meta-analyses), where they reported on eligible interventions, had a clear review question, and used at least two searching sources;
- evaluated interventions which were *predominantly* based on the principles of applied behaviour analysis;
- considered comparators including usual care, another intervention or application of interventions;
- reported on individuals with a diagnosis of autism spectrum disorder or where results are reported separately for this group;
- reported on at least six participants with ASD in either intervention or comparator arm;
- presented data on at least one standardised and/or quantitative outcome measure relevant to outcomes identified in the research question.

Research papers were **excluded** if they:

- were non-systematic reviews, correspondence, editorials, expert opinion articles, comments, case reports, book chapters, articles published only in abstract form, conference proceedings, news items, unpublished work;

- were case series, case studies, uncontrolled studies without a comparison group, or were single case experimental study designs (except where reported in included systematic reviews);
- reported on people diagnosed with Rett's Disorder or Childhood Degenerative Disorder;
- did not provide separate analyses/syntheses of results for eligible interventions;
- were not deemed appropriate to the research question or nature of review, including those reporting on outcomes solely relating to safety; the acceptability of, or ethical, economic or legal considerations relating to ABA; or the impact on persons other than those diagnosed with ASD.

KEY FINDINGS AND CONCLUSIONS

- Of 1517 articles identified by the search strategy, 43 publications were identified as eligible for appraisal and inclusion in the review. These were: 21 systematic reviews or evidence-based guidelines, and 20 primary studies (8 randomised controlled trials (RCTs), one quasi randomised study, 3 cohort studies and 8 non-randomised experimental studies).
- This systematic review provides consistent evidence across a range of studies of reasonable quality that interventions based on the principles of ABA can produce beneficial outcomes in young children with ASD, and appear to hold more promise when compared to eclectic/standard care approaches.
- The majority of primary studies evaluated variations on early intensive behavioural intervention (EIBI) programmes. Evidence from two of three studies which compared interventions of similarly high intensity suggests that EIBI can improve language skills, IQ and adaptive behaviour, although individual responses were highly variable. From comparisons of programmes of varying intensity, there was insufficient evidence to recommend the optimal number of intervention contact hours, although one study found that effectiveness diminished beyond 20 hours per week. Comparisons between interventions delivered by clinic staff and those of similar intensity directed by parents (with some specialist training or supervision provided) did not reveal differences in outcomes for participants with ASD.
- The Picture Exchange Communication System (PECS) can lead to positive effects for preschoolers and primary school children with ASD, although these may not be maintained beyond treatment.
- There was generally consistent evidence that video modelling can lead to positive impacts for children with ASD, and qualified support for social skills interventions generally. There was insufficient evidence to determine the effects of a range of other behavioural intervention approaches evaluated in single studies.

- There is consistent review evidence that behavioural interventions can reduce challenging or problem behaviour dramatically, although evidence is lacking concerning whether these effects are maintained or generalised.
- Functional behaviour analysis conducted prior to an intervention increases its effectiveness, and there is evidence to support experimental functional analysis as a particularly effective FBA approach.
- Identifying patterns in the study results was limited by the heterogeneity of the evidence base, reflected in varying intervention approaches, treatment intensity, comparators, study settings, sample characteristics (particularly age of participants), and outcomes.
- This report extends and strengthens the ASD Guideline's (Ministries of Health and Education 2008) recommendations relating to ABA. It identifies emerging evidence for superior benefits of behavioural approaches over eclectic/standard care approaches in education, treatment and managing problem behaviour for people with ASD in their early childhood. However this finding should be treated with caution as results were not always consistent, the number of studies where potential confounding factors were controlled were few, and responses to interventions between individuals were highly variable.
- Future research is needed to maximise treatment success and the direction of available resources by identifying the specific characteristics of behavioural treatment and the individuals receiving it that lead to best results.
- The current review's findings should be considered in conjunction with those of an independent systematic review conducted in parallel for the Ministries that included SCED primary studies. It is recommended that the findings of this report are reviewed and updated as relevant high quality evidence emerges.

BACKGROUND

Following the New Zealand Government review of autism services in 1998 ('the Curry Report'), the Ministry of Education and Ministry of Health ('the Ministries') sponsored and funded the development of a New Zealand Autism Spectrum Disorder (ASD) Guideline. A draft was released for consultation in December 2006 and feedback was sought from across the health, education, disability and social service sectors, as well as from individuals and families affected by ASD. A number of the submissions related to the use of Applied Behaviour Analysis (ABA). Some literature relating to ABA interventions was nominated by submitters in the consultation process (Ministries of Health and Education 2007).

In response to comments received, the Ministries put out an open Request for Tender (RFT) for an independent, systematic review of published research on the effectiveness of applied behaviour analysis interventions for people with ASD. Two review groups were contracted by the Ministry of Education to provide parallel reviews, the New Zealand Guidelines Group (NZGG), and a team of New Zealand academics with expertise in ABA, led by Dr. Oliver Mudford (University of Auckland).

The findings from both reviews will be considered by the ASD cross government Senior Officials Group (the Senior Officials Group) and, where they identify implications for the current Guideline on ASD (Ministries of Health and Education 2008), these will be considered by the ASD Living Guideline Working Group (LGWG).

AUTISM SPECTRUM DISORDER

ASD is a group of pervasive developmental disorders that affects communication, social interaction and adaptive behaviour functioning. Generalising from recent overseas data, ASD is thought to affect more than 40,000 New Zealanders (Ministries of Health and Education 2008).

Subgroups of ASD include Pervasive Developmental Disorders (PDD), classical autism, Asperger syndrome, and Pervasive Developmental Disorders – Not Otherwise Specified (PDD-NOS) (as defined in ICD-10 and DSM-IV diagnostic manuals).

Core features of people diagnosed with ASD are evident in three areas:

- impairment in the ability to understand and use verbal and non-verbal communication;
- impairment in the ability to understand social behaviour, which affects their ability to interact with other people;
- impairment in the ability to think and behave flexibly which may be shown in restricted, obsessional or repetitive activities.

Associated features of ASD may include:

- severe problem behaviours, such as tantrums, self-injury, and aggressive behaviour;
- attention and concentration problems;
- sleep disturbance;
- unusual responses to sensory stimuli;
- special skills and interests, such as a talent for music, mathematics, visual-spatial abilities, or an exceptional memory for areas of knowledge of particular interest;
- an outstanding rote visual or auditory memory and a high intelligence quotient (IQ) for some individuals.

There is a diverse range of disability and intellectual function expressed by people with ASD, from severe impairment of a person with classical autism, to a 'high functioning' person with Asperger syndrome. A wide range of intervention and supportive care services and approaches are required to reflect the heterogeneity of the condition.

APPLIED BEHAVIOUR ANALYSIS

Behavioural interventions have been variously described as involving the use of applied behaviour analysis, positive behaviour support, behaviour modification, behavioural programming, etc. Behavioural interventions are typically applied as a treatment package that can often include a diverse range of assessment and intervention procedures. However, all behavioural interventions are based on the science of Applied Behaviour Analysis (Ministries of Health and Education 2008), an applied science that focuses on the causes of socially significant behaviour change.

ABA-based interventions can be defined as 'those in which the principles of learning theory are applied in a systematic and measurable manner to increase, reduce, maintain and/or generalise target behaviours' (Ministries of Health and Education 2007). Well-established principles and techniques of ABA include (a) reinforcement, (b) shaping, (c) chaining, (d) fading, (e) response and stimulus prompting, (f) discrimination training, (g) programming, and (h) functional assessment.

The recently released New Zealand ASD Guideline (Ministries of Health and Education 2008) considers ABA approaches in relation to teaching and learning of adaptive behaviours (eg, communication skills, social skills, daily living skills), and replacement of challenging behaviour. The Guideline introduces ABA approaches in people with autism, defining early ABA research as that which used instructional techniques such as discrete trial training (DTT), as used in the Lovaas Young Autism Project (Lovaas 1987). In DTT, a task or trial is isolated and taught by repeated presentations to an individual, with successes reinforced and responses recorded, until the individual has demonstrated mastery. Interventions such as Early Intensive Behavioural Intervention (EIBI) and Intensive Behavioural Intervention (IBI) often use a discrete trial format in combination with more naturalistic teaching arrangements. Contemporary ABA approaches include procedures such as pivotal response training, incidental teaching, naturalistic teaching and milieu teaching. These have

often been conducted in the context of functional routines (eg, requests for preferred foods are taught during lunch, requests for preferred toys are taught during play) (Prizant and Wetherby 1998).

With respect to problem behaviours, the Guideline (Ministries of Health and Education 2008) explicitly endorses ABA approaches: “behaviour management techniques should be used to intervene with problem behaviours” (Recommendation 4.3.4). Further, it recommends, “all behavioural interventions should be of good quality and incorporate the following principles: person-centred planning, functional assessment, positive intervention strategies, multifaceted interventions, focus on environment, meaningful outcomes, focus on ecological validity and systems-level intervention” (Recommendation 4.3.5).

Where the ASD Guideline (Ministries of Health and Education 2008) considers interventions aimed at addressing challenging behaviour in education settings, it advises that “educational interventions should incorporate principles of positive behaviour support, particularly a focus on understanding the function of the child’s behaviour” (Recommendation 3.2.5.2). This approach is reflected in functional analysis or assessment, an ABA-grounded approach based on evidence that problem behaviours are often maintained by reinforcement contingencies. This also applies to challenging behaviours. Functional assessments attempt to identify variables that reliably evoke and maintain the problem behaviour. More appropriate behaviours are then identified and taught in an attempt to replace the problematic behaviour, or the environment can be modified to eliminate the triggers for the behaviour (Ministries of Health and Education 2008).

Functional communication training (FCT) is an ABA-based approach which aims to identify the communicative function of a (problem) behaviour and then replace the problem behaviour by teaching communication skills that serve the same function or purpose as the problem behaviour.

The ASD Guideline (Ministries of Health and Education 2008) also identifies the Picture Exchange Communication System (PECS) as a prominent intervention to promote initiation of non-speech communication. PECS is based on ABA principles, including the use of response prompting, prompt fading and differential reinforcement. With PECS, individuals are initially taught to exchange stimulus, response and reward. People are encouraged to exchange picture symbols to communicate.

Video modelling is also highlighted in the Guideline (Ministries of Health and Education 2008). It is based on the ABA principle of modelling, where a video image is used to convey meaningful information or correct performance of an action, by either presenting images of peers, actors, or (in video *self* modelling) edited footage of the targeted individual.

Overall, the ASD Guideline (Ministries of Health and Education 2008) does not favour any particular educational intervention:

“There is no evidence that any single model is effective for teaching every goal to all children with ASD. Models should be chosen to fit the

characteristics of the child and the learning situation” (Recommendation 3.1.2).

It further advises, “decisions about the type of intervention and the degree of intensity should be informed by a skilled team and reflect the child’s developmental stage, characteristics, teaching goals and family preferences” (Recommendation 3.1.3). Whilst the Guideline suggests that programme intensity is required for children aged under eight years with ASD, it is not able to recommend an optimal amount of intensity. It notes under ‘Implications for practice’ (Section 3.1.c) that “the quality of the intervention/education is at least as important as its intensity” (page 91).

With respect to management of ASD using psychological approaches, the Guideline recommends that, “the feasibility of establishing publicly funded, ASD-specific behavioural services should be investigated” (Recommendation 4.3.7).

SCOPE OF REVIEW

The review scope was developed by NZGG based on that defined in the Ministries’ RFT (2007) and modified in consultation with the Senior Officials Group. It was agreed that, consistent with NZGG’s expertise, NZGG’s review would be restricted to primary research employing group designs, and secondary research (of various study designs) meeting other agreed selection criteria.

The current review explicitly excludes (primary) studies that employ single case experimental design (SCED) studies. It is acknowledged that a significant number of studies concerning behavioural interventions in people with autism spectrum disorder, including those relating to ABA, employ SCED methodologies. These small sample studies consider participants as their own control within a tight experimental design, and include “n of 1” studies, ABAB designs (where A is the control phase and B is the intervention), alternating treatment and multiple baseline designs.

Conduct and appraisal of SCED studies is a specialist area. Quality criteria, appraisal checklists and hierarchies of evidence have been developed specifically for these study designs (Logan et al, 2008), and may vary from those used for group study designs. There is currently no clear consensus within the evidence based practice community about where SCED studies “fit” within group study design hierarchies of evidence, and this is an area of ongoing development and debate. There is a view that the appraisal and evidence ranking of SCED studies and group studies are best considered as “parallel frameworks” (Professor Susan Harris, *personal communication*, 27 May 2008).

The Ministries have also contracted another team to conduct a review on the same topic, led by Dr. Oliver Mudford (University of Auckland). This team has particular expertise in SCED studies and will include these in their review (among other study design types).

It is anticipated that the two review approaches, conducted independently and in parallel for the Ministries, will provide complementary, and overlapping streams of evidence-based conclusions. As the two review teams plan to employ different critical appraisal and evidence grading methodologies for considering these overlapping

studies, the project provides an opportunity for comparison and cross validation of review conclusions.

To maximise the benefit of having two independent approaches to the review, the two review teams have had only brief contact during the start-up phase to ensure broad agreement on the scope of the reviews, particularly with respect to what interventions to consider under the ABA umbrella, as this is an area of ongoing debate. A meeting was held in June 2008 hosted by the Ministry of Education and attended by key members of both review teams and the Senior Officials Group. The meeting focused on presentations from both teams of their planned methods. A follow-up teleconference was held between representatives of both teams to share search terms, and discuss eligibility of specific interventions. Apart from these meetings, the teams have worked independently, with only brief contact about technical issues prior to study selection.

The systematic review has taken a broad approach in terms of considering interventions predominantly grounded in ABA, and outcomes that relate to the person with ASD. These included comprehensive outcomes (addressing overall functioning and multiple symptoms over the long term) and focal outcomes (problematic or undesirable behaviours). Whilst recognised as important, outcomes relating specifically to the person with ASD's family or caregivers were beyond the scope of this review. The review did not systematically consider evidence for the acceptability of, or ethical, economic or legal considerations associated with ABA interventions.

OBJECTIVES

The objective of the review is to consider the effectiveness of ABA interventions for treating people with ASD.

RESEARCH QUESTION

What extent are interventions and strategies based on applied behaviour analysis effective in leading to the following outcomes for people with autism spectrum disorders (Ministries of Health and Education 2007):

- social development and relating to others;
- development of cognitive (thinking) skills;
- development of functional and spontaneous communication which is used in natural environments;
- engagement and flexibility in developmentally appropriate tasks and play and later engagement in vocational activities;
- development of fine and gross motor skills;
- prevention of challenging behaviours and substitution with more appropriate and conventional behaviours;
- development of independent organisational skills and other behaviours;

- generalisation of abilities across multiple natural environments outside the treatment setting;
- maintenance of effects after conclusion of intervention;
- improvement in behaviours considered non-core ASD behaviours, such as sleep disturbance, self mutilation, aggression, attention and concentration problems.

METHOD

A systematic method of literature searching, selection and appraisal was employed in the preparation of this report, consistent with New Zealand Guidelines Group processes (New Zealand Guidelines Group 2001).

SEARCHING

A literature search was undertaken in late June 2008 using the following bibliographic and guideline databases and websites:

- PsycINFO
- Medline
- Cinahl
- Embase
- ERIC
- Cochrane Library
- National Guideline Clearing House (www.guideline.gov/)
- U.S. Preventive Services Task Force (<http://www.ahrq.gov/clinic/uspstfix.htm>)
- Agency for Healthcare Research and Quality (www.ahrq.gov/)
- Health Services Technology/Assessment Texts (hstat.nlm.nih.gov/)
- Canadian Medical Association Inforbase (Clinical Practice Guidelines) (<http://mdm.ca/cpgsnew/cpgs/index.asp>)
- Scottish Collegiate Guidelines Network (<http://www.sign.ac.uk/>)
- National Institute for Health and Clinical Excellence (UK) (<http://www.nice.org.uk/>)
- Guidelines International Network (<http://www.g-i-n.net>)
- Canadian Agency for Drugs and Technologies in Health (www.cadth.ca/)
- TRIP database (<http://www.tripdatabase.com/index.html>)
- International Network of Agencies for Health Technology Assessment (www.inahta.org/)
- Medical Services Advisory Committee (Australia) (<http://www.msac.gov.au/>)
- Australia and New Zealand Horizon Scanning Network (<http://www.horizonscanning.gov.au/>)
- New Zealand Health Technology Assessment (<http://nzhta.chmeds.ac.nz/>)
- National Health and Medical Research Council – Australia (<http://www.nhmrc.gov.au/>)
- BMJ Clinical Evidence (<http://clinicalevidence.bmj.com/ceweb/index.jsp>)

Searches were restricted to English language material published between the years 1998 and 2007, inclusive.

Search terms/keywords were combined for autism [including autism/ aspergers syndrome/ autistic thinking/ pervasive developmental disorders/ kanner/], and intervention keywords, types and methods (eg, applied behaviour analysis, intervention programme, functional analysis or assessment, discrete trial training, prompting, modelling). Study design filters were applied to these results to identify randomised controlled trials, meta-analyses, systematic reviews, other comparative, observational studies, and evaluation or outcome studies.

Full details of search strategies are described in **Appendix 1**.

The literature identified was supplemented by an additional 151 publications identified in the RFT (Ministries of Health and Education 2007). These were identified from those submissions which were relevant to the review made during the consultation process for the draft ASD Guideline, where these identified new citations.

Bibliographies of retrieved publications, and recent narrative reviews, were also examined to identify any additional eligible studies. It should be noted that narrative reviews retrieved for this purpose or to provide background material were not critically appraised for inclusion in the review.

Hand searching of journals, searching of sources of grey literature, and contacting of authors for unpublished research was not undertaken. However a small number of authors were contacted for methodological clarifications.

STUDY SELECTION CRITERIA

Publication type

Studies published between 1998 – 2007 inclusive, in the English language, including primary (original) research published as full original reports and secondary research (systematic reviews and meta-analyses).

Participant characteristics

The study population were individuals with a clinical diagnosis of autism spectrum disorder from a relevant professional (e.g., psychologist, paediatrician) and/or as classified by standardised assessments (e.g., DSM-IV-R, ICD-10, ADOS, ADI), or where results are reported separately for this group.

Individuals of any age diagnosed with any of the following:

- Autism;
- Asperger syndrome;
- Pervasive Developmental Disorder (PDD);
- PDD Not Otherwise Specified (PDD NOS).

A range of other disorders may be diagnosed as co-occurring with autism or PDD including attention deficit/hyperactivity disorder (ADHD), intellectual disability, obsessive compulsive disorder, developmental disorders of motor function and, most

commonly, specific and general learning problems. Studies involving participants who have a dual diagnosis were included.

Individuals diagnosed with Rett's Disorder or Childhood Degenerative Disorder were *excluded*.

Interventions

Many interventions in this area offer a mix of approaches which commonly include features grounded in learning theory and reflecting ABA principles. However evaluations of interventions (or combined approaches) were only included in the current review where they were considered to be *predominantly* based on the principles of applied behaviour analysis and which were implemented for the purpose of treating individuals with ASD.

Applied behaviour analysis is defined as an intervention in which the principles of learning theory are applied in a systematic and measurable manner to increase, reduce, maintain and/or generalise target behaviours. Interventions included those which were described as predominantly behavioural interventions or behavioural support or behavioural modification or behavioural treatment, or whose techniques were predominantly based on the use of well-established principles of ABA (eg, reinforcement, shaping, chaining, response prompting, stimulus control, prompting, modelling, token economy, punishment, contingencies, fading, discrimination training, generalisation, operant conditioning, establishing operations, functional assessment or functional analysis).

Comparators

Usual care, another intervention or application of interventions (eg, intensity of intervention, eclectic approach).

Study design

Single case/subject experimental study designs (including "n of 1" studies, ABAB designs, alternate allocation, multiple baselines) were excluded.

Systematic reviews and meta-analyses were eligible for appraisal where they reported on eligible interventions (solely or separately as a synthesised sub-group), had a clear review question and accessed at least two searching sources. Search sources needed to include one bibliographic database *plus* at least one of the following: another bibliographic database, reference checking of retrieved articles, google scholar/web of science to check antecedent or descendent citations or handsearching of a number of key journals.

Table 1: Designations of levels of evidence for evaluating intervention studies

Level of evidence	Study design
I	A systematic review of level II studies
II	RCT(s) of good quality
III-1	Pseudo-randomised controlled trial (eg, alternate allocation or other method)
III-2	A comparative study with concurrent controls Non-randomised experimental trial - a controlled before-and-after study - an indirect comparison of two RCTs (ie, A vs B and B vs C) Cohort study Case-control study Interrupted time series with a control group
III-3	Comparative study without concurrent controls: Historical control study Two or more single arm study Interrupted time series without a parallel control group
IV	Case series with either post-test or pre-test/post-test outcomes

National Health and Medical Research Council. (2008)

Study designs can be ranked in a hierarchy according to their “level of evidence” (National Health and Medical Research Council 2008), which reflects the effectiveness of the study design to answer a research question. Eligible study designs were limited initially to those that provide at least level III-3 level of evidence (see **Table 1**). That is, uncontrolled studies without a comparison group including case reports and case series (level IV evidence) were excluded.

The precise ‘cut-off’ point in the hierarchy for study designs included was considered after other selection criteria had been applied. The goal was to identify evidence at higher levels of the hierarchy, consistent with a reasonable number of articles (see “study selection” section).

Sample size

Small sample studies of six or more participants in either intervention or comparator arm. Studies where participants diagnosed with ASD (in either study arm) were five or fewer were excluded as a study quality criterion for group study designs.

Outcomes

Studies using at least one standardised and/or quantitative outcome measure of, and analyses for, at least one of the following outcomes relating to effectiveness of relevant interventions:

- social development and relating to others;
- development of cognitive (thinking) skills;
- development of functional and spontaneous communication which is used in natural environments;
- engagement and flexibility in developmentally appropriate tasks and play;

- engagement in vocational activities (as an adult);
- development of fine and gross motor skills;
- prevention of challenging behaviours and substitution with more appropriate and conventional behaviours;
- development of independent organisational skills and other behaviours;
- generalisation of abilities across multiple natural environments outside the treatment setting;
- improvement in behaviours considered non-core ASD behaviours, such as sleep disturbance, self mutilation, aggression, attention and concentration problems;
- maintenance of effects after conclusion of intervention.

Study exclusion criteria

Research papers were **excluded** if they:

- were published prior to 1998, or after 2007 (however earlier primary studies may be reported in included systematic reviews);
- were non-systematic reviews, letters, editorials, expert opinion articles, comments, case reports, book chapters, articles published only in abstract form, conference proceedings, correspondence, news items, unpublished work;
- were not published in the English language;
- reported on samples of five or fewer participants in either arm of the study (intervention or comparator);
- were case series, case studies or uncontrolled studies;
- were single case experimental study designs (except where considered and reported in included systematic reviews);
- reported solely on people diagnosed with Rett's Disorder or Childhood Degenerative Disorder;
- were not deemed appropriate to the research question or nature of review, including:
 - (i) studies that assessed the effectiveness of interventions that were *not* predominantly grounded in the central features of an ABA approach;
 - (ii) comparisons of behavioural phenotypes;
 - (iii) studies describing cognitive concepts (eg, executive function, theory of mind);
 - (iv) screening, diagnosis and assessment studies;
 - (v) studies describing service provision (without evaluation);
 - (vi) studies describing the process of training and accreditation of ABA practitioners;
 - (vii) studies describing the general scientific method for assessment of studies;

- (viii) litigation issues;
- (ix) outcome measure or diagnostic test development;
- assessed the following interventions: sensory integration therapies; auditory integration therapies; specifically developmentally based programmes; “TEACCH”; “floor time”; “Son-Rise”; “gentle teaching”; contact with animals (eg, dolphins, horse-back riding); facilitated communication; the Miller method; chelation therapy;
- reported solely on outcomes relevant to safety (without accompanying effectiveness data); the acceptability of, or ethical, economic or legal considerations associated with ABA interventions; or the impact of the intervention on persons other than those diagnosed with ASD.

STUDY SELECTION

Selection criteria were applied by a single reviewer to abstracts/titles identified by the search strategy to identify a subset of potentially eligible articles for retrieval as full text. Selection criteria were then applied to the full text articles by two reviewers to identify the final set of included papers for critical appraisal and inclusion in the evidence tables. Double coding processes (and therefore inter-rater reliability analyses) were not undertaken.

There is no clear consensus in the literature about what defines an intervention as ABA-based. Making decisions about whether an intervention was ABA-based was at times challenging as many interventions offer a mix of approaches which included features based on ABA principles. Whilst explicit criteria were employed as described under the study selection section, the judgement of whether an intervention was “*predominantly ABA*” therefore involved weighing the ABA component of the approach from the description given in the paper’s methods. Where there were doubts about study inclusion, reviewers consulted Professor Jeffrey Sigafos who was provided with the full text papers, as required.

Reasons for exclusion were coded hierarchically such that the first reason for exclusion that was reached was applied, even though multiple reasons for exclusion may apply. Reasons for exclusion were coded as follows:

1. Wrong publication
 - including non-systematic/narrative reviews¹, case reports, book chapters, animal studies, short notes, letters, editorials, conference abstracts, in vitro studies;
 - studies not deemed appropriate to the research question or nature of the review;
 - single case experimental design studies
2. Wrong intervention
3. Wrong comparator

¹Some of these studies could be retrieved as background material or to assist in identifying additional eligible studies, but were still coded as ineligible in the report’s appendix.

4. Wrong indication/population/setting
5. Wrong outcomes
6. Wrong study design (if a reasonable number of higher level evidence studies has been identified by the review).

The exclusion criteria for “wrong study design” was applied last, after exclusion criteria 1-5. Initially, studies were excluded at this stage if they were at level of evidence III-3 or below (studies without a parallel control group, or uncontrolled case series). Once selection criteria had been fully applied, the quantity and level of evidence included within the hierarchy of evidence (see **Table 1**) was considered. The goal was to include only the highest levels of evidence, as consistent with a reasonable number of studies. If a reasonable number of higher order study designs had not been identified as eligible for inclusion at that point, studies excluded for being the “wrong study design” (ie, level III-3) could be reconsidered for inclusion. Exceptions to this process were single case experimental design studies and case series or reports which were excluded preferentially as wrong publications (exclusion reason 1).

APPRAISAL METHODOLOGY

Levels of Evidence were applied to each included study so as to rank them according to a pre-determined “evidence hierarchy”. These rankings are based on the probability that the design of the study has reduced or eliminated the impact of bias on the results. We employed the NHMRC (2008) interim levels of evidence hierarchy (see **Table 1**). Systematic reviews of randomised controlled trials represent the highest level of evidence (level I) for studies of intervention effectiveness.

Whilst these evidence levels describe groups of research which are broadly associated with particular methodological limitations, these levels are only a general guide to quality. Each study may be designed and/or conducted with particular strengths and weaknesses which can be assessed using critical appraisal tools. In this review, included studies were formally appraised using the quality checklists from the Scottish Intercollegiate Guidelines Network as appropriate to study design, including those for systematic reviews, randomised controlled trials, and cohort studies (see <http://www.sign.ac.uk/methodology/checklists.html>). The quality and resistance to risk of bias of an individual study was scored as either ++ (very good), + (good) or – (fair).

PRESENTATION OF RESULTS

After critical appraisal of individual studies and assignment of a level of evidence, details of each study were entered in evidence tables. Results are presented in evidence tables and summarised in text and tabular form, where appropriate.

The evidence and results tables for appraised studies were ranked and presented in order of level of evidence (higher level study designs reported first), and within each study design type, in reverse chronological order (most recent publications first), and where necessary, alphabetically by first author within each year.

DATA SYNTHESIS

It was not possible to perform a quantitative synthesis of the data retrieved because of the degree of heterogeneity of the populations and interventions studied and the lack of high quality RCTs in the topic area.

Data were summarised and synthesised narratively and in tables, as appropriate. Studies were grouped according to broadly similar interventions (eg, early intensive behavioural interventions), and where intervention programme intensity and mode of delivery (parent- or expert-directed) were controlled.

Studies were narratively synthesised to determine the strength of evidence. Strength of evidence is determined by three domains (West et al. 2002):

quality (of the individual studies predicated on the extent to which bias was minimised);

quantity (magnitude of effect, numbers of studies, and sample size or power); and

consistency (the extent to which similar findings are reported using similar and different study designs).

LIMITATIONS OF THE REVIEW METHODOLOGY

A structured and systematic approach was employed in reviewing the literature. However, conclusions from systematic reviews are limited by the review's methodology and the quality of the studies identified and included for appraisal.

This review has been limited by the restriction to publications in the English language, which may result in study bias. However, reference checking of retrieved reviews did not identify any primary study that had been missed due to language restriction.

The review was limited to the published academic literature which may lead to publication bias and/or over estimation of the benefits of treatments; small-sampled studies are more likely to be published if they report 'positive' findings whereas larger studies tend to be published regardless of findings. As a minimum quality criterion, small-sampled group studies ($n < 6$) in either arm were excluded.

The studies were initially selected by examining abstracts and so some studies may have been inappropriately excluded prior to examination of the full-text article. To minimise this possibility, where detail was lacking or ambiguous, papers were retrieved as full text. The expert consultant (Professor Sigafoos) was consulted where there were doubts about eligibility. As discussed under "study selection", the judgements of this were at times challenging due to the lack of consensus about what interventions represent ABA in the research community, and it is recognised that some readers will come to different conclusions about which interventions are "predominantly based" in ABA. For example, whilst the "social stories" intervention has clear ABA components it was not considered to be "*predominantly* ABA" in this report. In response to the variation of viewpoints on this issue, results and related conclusions are organised by intervention type in this review.

Another challenge related to defining systematic reviews. The current review required that they reported on eligible interventions (solely or separately as a synthesised subgroup), had a clear review question and accessed at least two searching sources (including at least one bibliographic database). This approach may have excluded reviews due to poor reporting. It was not feasible in the timeframe to systematically contact all authors of potentially eligible review papers to identify such information. Alternatively, narrative reviews may have met eligibility criteria due to use of a systematic search and been included in the review, despite not having systematic identification, appraisal or synthesis processes. Therefore the selection criteria could be regarded as being overly inclusive. Study quality rated for included reviews is a good indicator of the degree to which they were systematic.

Another decision point that affected selection of studies was around whether the review aims were relevant to the current topic scope. Several reviews were included which had a broader focus than ABA interventions, but they were included only if they reported on and synthesised at least a subset of ABA studies. A particularly problematic study was the Cochrane review by Diggle et al (2002) which met methodological selection criteria as a systematic review (SR) and was relevant to ABA. However it was decided that the study was not eligible for inclusion as its review aim was to consider parent-directed interventions for children with ASD (which may or may not include ABA based procedures). The review scope was therefore not a systematic attempt to identify and report on ABA interventions or a subset of such. The two RCTs in the Diggle review were included as primary studies in the current review as they separately met the inclusion criteria.

An inclusion criteria related to study participants having received a clinical diagnosis of autism spectrum disorder from a relevant professional and/or as classified by standardised assessments. It is noted that there is not complete agreement between classification systems (which have altered over time) or diagnostic methods for autism. The definitions used for ASD, where available, are reported in the Evidence Tables for ease of comparison. In a small number of studies, details were lacking about the diagnostic tools employed for identifying participants as eligible for inclusion in the study, however studies were only included where participants were stated as having received a clinical diagnosis for ASD.

As an additional check that papers were neither missed by the search strategy nor erroneously excluded based on abstract, cross-checking of references of retrieved papers, including those of a number of narrative reviews retrieved as background, was employed to identify additional potentially eligible articles.

The publication dates of papers eligible for inclusion were restricted to 1998 – 2007 inclusive. This date range was specified by the RFT (2007) so as to be consistent with the search period of the New Zealand ASD Guideline (Ministries of Health and Education 2008). It is recognised that investigations of ABA interventions precede these dates; however using the included systematic reviews in the current report would be expected to incorporate that literature. It is recognised that this is an active area of research and that the results and conclusions will need to be revisited in the future in order to incorporate new research developments.

Data extraction, critical appraisal and report draft preparation were performed by two reviewers over a limited timeframe (July to early October, 2008). Double-coding and inter-rater reliability analyses were not conducted. For a detailed description of interventions, methodology, measurement, and analyses in the studies appraised, the reader is referred to the original papers cited.

This review has benefited from comments provided by the expert consultant (Professor Sigafoos), NZGG Research Services Manager Dr Jessica Berentson-Shaw, and two double-blind external peer reviewers contracted by the Ministry of Education.

RESULTS

SEARCH RESULTS

There were 1517 references identified by the full search strategy. These included 55 unique articles (after excluding 96 duplicates) from the 151 which the Ministry of Education asked to be considered for eligibility in the review. These 151 papers were suggestions from submissions made in the consultation process following release of the draft ASD Guideline.

Of the total 1517, 1329 were excluded based on application of selection criteria to titles and abstracts, leaving 188 potentially eligible articles. These articles were retrieved as full text and 145 were found to not fulfil inclusion criteria and were also excluded, leaving 43 eligible publications.

It should be noted that the additional 151 additional references provided by the Ministry of Education identified 12 of the included papers. Eleven of these were independently identified by the bibliographic search strategy developed for the review, and the other study was also identified in reference checking.

All 1474 excluded papers are listed in **Appendix 2**, appended by key reason for exclusion. The vast majority of studies (n=1409) were excluded for being wrong publication, commonly because they were not primary, controlled group studies relevant to the research question. Fifty-six were excluded as they considered the wrong intervention; that is, an intervention which was not predominantly ABA-based. Six studies were excluded as relating to the wrong population (eg, a sample of people with Rett's Disorder). Three were excluded as investigating the wrong outcomes (eg, limited to measuring the impact on carers of people with ASD). No studies (meeting all other selection criteria) were excluded as "wrong study design" as all represented study designs at NHMRC (2008) evidence level III-2 or above (studies with a parallel control group). Note, single case experimental design studies and case reports/series were excluded as wrong publication.

The 43 eligible publications reported on 41 studies, which were critical appraised. Included publications are listed in **Appendix 3**.

DESCRIPTION OF STUDIES

Included studies and levels of evidence

Of the 41 studies that met the review's selection criteria, 21 were systematic reviews or evidence-based guidelines and 20 were primary studies.

Of the 21 secondary studies, 10 reviewed RCTs and/or systematic reviews (Level I evidence), including 9 which had no design limitations on studies for inclusion, and 1 which sought to find 'critical reviews' only.

Eleven secondary studies were reviews of level III-2 evidence (and were classified as level III-1 evidence). These included nine reviews/guidelines which synthesised single case experimental design (SCED) studies, one which synthesised non randomised studies and one which included only higher quality evidence (systematic reviews and RCTs, but observational studies were also accepted if no other evidence was identified).

Of the 20 primary studies, there were eight RCTs (level II evidence), one quasi randomised study (level III-1 evidence), and three cohort studies and eight non randomised experimental studies (level III-2 evidence). For two of the primary studies, there were two articles published reporting on each study, with the second publication either reporting on outcomes at longer follow up (Eikeseth et al. 2002; Eikeseth et al. 2007), or reporting on different outcomes than the first publication (Yoder and Stone 2006a; Yoder and Stone 2006b).

Details on the included studies are provided in the full Evidence Tables (**Appendix 4**) and a summary of participants, settings, interventions, comparisons and outcomes in included studies (**Table 2**). These tables are ordered according to level of evidence (higher level studies reported first) and within each study design type, in reverse chronological order (most recent publications first), and, where necessary, in alphabetical order within year.

Participants

Participants in the included studies were diagnosed either with autism, 'autistic disorder', ASD or PDD NOS. One study included children with a range of psychiatric problems such as anxiety disorders, depression and attention deficit disorder, but results were available separately for children with autistic disorders. One review required at least one participant in the studies considered for inclusion to have ASD and another review required at least 75% of participants in included studies to have ASD. One study specified that participants have autism or ASD and specifically excluded participants with PDD and/or ASD. One study required participants to have both autism and mental retardation.

Most of the participants in the studies were preschool children. Two studies did not report age criteria, participants in 8 studies were described as 'children' without clarification, 6 studies included children in either preschool or elementary school, 7 studies included students of school age (one up to age 21 years) and 18 studies were limited to preschool children. Of these 18 studies, only 2 required children to be aged less than 3 years; another 3 studies included children aged between 1½ or 2 years and 3½ years.

Table 2: Summary of quality scores, participants, settings, interventions, comparisons and outcomes in included studies

Study/quality score	Participants	Setting(s)	Intervention(s)	Comparison(s)	Outcome(s)
Systematic reviews/guidelines (level I)					
(Parr 2007) BMJ Clinical Evidence Report ++	Children or adolescents with autism or ASD (PDD NOS and AS excluded)	Not reported	All treatments assessed. Separate results for: <ul style="list-style-type: none"> ▪ ABA (EIBI or Lovaas therapy) ▪ Autism Preschool Program ▪ PECS 	n/a	Not specified
(Scottish Intercollegiate Guidelines Network 2007) ++	Children and adolescents up to age 16 years	Not reported	All treatments assessed. Separate results for: <ul style="list-style-type: none"> ▪ EIBI 	n/a	'Normal functioning' Autistic symptoms not specified
(Roberts and Prior 2006) +	Children with ASD (age limits not reported)	Not reported	All treatments assessed. Separate results for: <ul style="list-style-type: none"> ▪ Behavioural intervention 	n/a	Not specified
(Burrows 2004) -	Children with autism	Not reported	Educational treatments. Separate results for: <ul style="list-style-type: none"> ▪ Lovaas treatment 	n/a	Global improvement (specific areas of functioning excluded)
(Doughty 2004) +	Young children with ASD	Not reported	Behavioural and skill based treatments. Separate results for: <ul style="list-style-type: none"> ▪ ABA treatment 	n/a	Not specified
(Finch and Raffaele 2003) ++	Children under 8 years with a diagnosis of autism or PDD	Not reported	EIBI	n/a	IQ Class placement Social and adaptive functioning
(Chorpita et al. 2002) +	Children with a variety of psychiatric conditions (anxiety, ADHD, etc). Results reported separately for children with ASD	Not reported	All treatments assessed. Separate results for: <ul style="list-style-type: none"> ▪ FCT/ABA ▪ DTT 	n/a	Overall functioning Focal improvement
(Ludwig and Harstall 2001) +	Children with ASD	Not reported	EIBI	n/a	Not specified
(McGahan 2001) +	Preschool children with autism or PDD	Not reported	Behavioural treatment	n/a	Not specified
(Bassett et al. 2000) ++	Preschool children with autism	Not reported	EIBI	n/a	Not specified

Study/quality score	Participants	Setting(s)	Intervention(s)	Comparison(s)	Outcome(s)
Randomised controlled trials (level II)					
(Howlin et al. 2007) +	Elementary school children (aged 4 to 11 years) with autism or ASD	Specialist classes or schools	1. PECS (immediate treatment) 2. PECS (delayed treatment)	No PECS treatment (standard care within classes)	Communication skills Language
(Kasari et al. 2006) +	Children with autism between 3 and 4 years of age	University clinic	1. EIBI with treatments aimed at joint attention 2. EIBI with treatments aimed at symbolic play	EIBI	Language Non verbal communication Structured play
(Yoder and Stone 2006b) (Yoder and Stone 2006a) ++	Children with autism or PDD NOS between 18 and 60 months of age	University clinic	PECS	Responsive Education and Prelinguistic Milieu Teaching (RPMT)	Communication skills Play Turn taking
(Sallows and Graupner 2005) +	Children with autism between 24 and 42 months of age	University clinic	Clinic directed EIBI	Parent directed EIBI (less supervision than clinic EIBI)	IQ Non verbal IQ Language Adaptive functioning Academic achievement Social functioning Behaviour Classroom placement
(Drew et al. 2002) -	Children with autism aged less than 2 years	Hospital clinic and local services	Psycholinguistic and social pragmatic approach using advice on behavioural management	Eclectic treatment (mixture of standard care including speech and language therapy, physiotherapy, home worker input and ABA)	Non verbal IQ Communication skills/social interaction Behaviour Parent stress
(Moore and Calvert 2000) -	Children with autism between 3 and 6 years of age	School	Behavioural programme	Behavioural programme + educational software programme	Learning nouns Attention to task Motivation to continue in programme
(Smith et al. 2000) +	Children with autism or PDD NOS aged between 18 and 42 months	University clinic	High-intensity clinic directed EIBI	Low intensity parent directed EIBI	Intellectual functioning Language Adaptive functioning Socioemotional functioning Academic achievement Class placement 'Progress' Parent satisfaction
(Jocelyn et al. 1998) +	Preschool children with autism or PDD aged between 24 and 72 months	Community based day care centre	Autism Preschool Program (APP)	Eclectic care (usual standard care with input from Family Services workers)	Knowledge of autism Autism symptomatology Developmental measures Family stress and satisfaction

Study/quality score	Participants	Setting(s)	Intervention(s)	Comparison(s)	Outcome(s)
Systematic reviews of SCEDs and/or group studies with concurrent controls (level III-1)					
(Bellini and Akullian 2007) ++	Children with ASD aged between 3 and 21 years	Not reported	Video (self) modelling	n/a	Communication skills/social interaction Behavioural functioning Functional skills
(Bellini et al. 2007) +	Children and adolescents with ASD	School	Social skills interventions	n/a	Social skills
(Delano 2007) +	People with ASD	Not reported	Video modelling	n/a	Communication skills/social behaviour Functional living skills Answering perspective-taking questions Challenging behaviour
(Machalicek et al. 2007) -	Children and adolescents with ASD aged between 3 and 21 years of age	Not reported	Behavioural interventions	n/a	Challenging behaviour
(Mancil 2006) +	Studies with at least 1 participant a child with ASD	Not reported	Functional communication training (FCT)	n/a	Communication skills Challenging behaviour
(Matson et al. 2007) -	Children with ASD aged 12 years of age or younger	Not reported	Social skills interventions	n/a	Social skills
(Ayres and Langone 2005) +	Children with autism (ranging from preschool to 20 years)	Not reported	Video based instruction	n/a	Social/communication skills Functional skills
(Campbell 2003) ++	People with autistic disorder	Not reported	Behavioural interventions	n/a	Problem behaviour
(Horner et al. 2002) +	Children with autism aged less than 8 years old	Not reported	Behavioural interventions	n/a	Problem behaviour
(McConnell 2002) +	Children with autism	Not reported	Social skills interventions	n/a	Social skills
(Smith 1999) +	Children with autism	Not reported	Multiple treatments. Separate results for: ▪ ABA	n/a	Not specified
Quasi experimental study (level III-1)					
(Kroeger et al. 2007) -	Children with autism aged between 4 and 6 years	Clinic/university setting	Video modelling by direct teaching	Behavioural intervention focussing on unstructured play	Social skills Play

Study	Participants	Setting(s)	Intervention(s)	Comparison(s)	Outcome(s)
Non randomised experimental and cohort studies (level III-2)					
(Carr and Felce 2007) -	Children with autism aged between 3 and 7 years	Classroom	PECS + eclectic intervention	Eclectic intervention only	Communication skills
(Eikeseth et al. 2002) (Eikeseth et al. 2007) +	Children with autism aged between 4 and 7 years	Kindergarten and school classrooms	EIBI	Eclectic intervention (mixture of approaches)	Intellectual functioning Visual spatial skills Language Adaptive functioning
(Magiati et al. 2007) +	Children with ASD aged between 22 and 54 months	EIBI based at home and Eclectic intervention based at school	Home based EIBI	Eclectic intervention (mixture of approaches)	Cognitive skills Adaptive behaviour Language Play Autism severity
(Reed et al. 2007) -	Children with autism aged between 2 years 6 months and 4 years	Home based	Home based EIBI	Home based low intensity behavioural treatment	Behavioural functioning Communication/social interaction Cognitive skills Adaptive functioning Developmental functioning
(Remington et al. 2007) -	Preschool children with autism aged between 30 and 42 months	EIBI was home based; usual care was offered from the community and both groups accessed publicly funded facilities	Home based EIBI	Eclectic care (usual standard treatment offered by statutory services)	Non verbal communication Intellectual functioning Language Adaptive skills Behavioural functioning Parent measures
(Zachor et al. 2007) -	Children with autism or PDD NOS aged less than 3 years	Programmes were based in 2 different centres	EIBI (centre based)	Eclectic developmental intervention (based on a mixture of approaches)	Language and communication Social interaction
(Cohen et al. 2006) -	Children with ASD or PDD NOS aged between 18 and 42 months	Dependent on the age of the child. EIBI initially mostly at home with a few hours at preschool – as the child aged, the balance between these 2 changed. Settings varied in the control group but mostly was based at school	EIBI (home based with a mixture of therapists and parents)	Eclectic intervention	IQ Non verbal IQ Language Adaptive behaviour Classroom placement

Study	Participants	Setting(s)	Intervention(s)	Comparison(s)	Outcome(s)
Non randomised experimental and cohort studies (level III-2) <i>continued</i>					
(Eldevik et al. 2006) -	Children with autism and mental retardation aged less than 6 years	Kindergarten or elementary school classrooms	Minimal intensity EIBI (one to one)	Minimal intensity eclectic intervention (one to one)	Intellectual functioning Language Adaptive behaviour Non verbal intelligence 'Pathology' data (assessment of a variety of symptoms and behaviours)
(Wetherby and Woods 2006) -	Children with autistic disorder or PDD NOS aged less than 2 years	Home based for the intervention group together with parent-child play groups	Early Social Interaction project (ESI) (incorporating the NRC recommendations) – implemented by parents	No treatment (this group was only measured at baseline and compared directly with the intervention group both before and after they had received ESI treatment)	Communication skills and symbolic behaviour
(Howard et al. 2005) -	Children with ASD or PDD NOS aged less than 4 years	EIBI based in multiple settings (home, school and community). Control groups based in classrooms	EIBI (delivered by both therapists and parents)	1. Intensive eclectic intervention (combination of methods) 2. Non intensive eclectic intervention (combination of methods)	Cognitive skills Non verbal skills Language Adaptive skills
(Sheinkopf and Siegel 1998) -	Preschool children with autism or PDD NOS	EIBI was based at home. Control comparison was based in the classroom	Home directed EIBI	Eclectic intervention (standard school based interventions)	Cognitive skills Behavioural functioning (frequency and severity of autistic behavioural symptoms)

Settings

Most of the included studies for the secondary studies used a variety of settings and results were not grouped according to setting, with the exception that one review was restricted to studies that implemented social skills interventions in a school setting (Bellini et al. 2007). Of the primary studies, all of the RCTs were undertaken either in university clinics or school/preschool classrooms. Most of the non randomised studies (n=7) were undertaken partly or wholly at home, sometimes with a mixture of parents and therapists implementing the intervention(s).

Interventions

Primary studies

Interventions in the included studies varied widely. Twelve studies assessed the effects of different variants of 'early intensive behavioural interventions' (EIBI), but programme delivery varied. Five of the studies assessed the effects of clinic-directed EIBI. Another four studies assessed the effects of EIBI delivered in the home (usually by parents). One study assessed the effects of a 'minimal intensity' early behavioural intervention (Eldevik et al. 2006), and one study assessed the effects of a EIBI delivered in a mixed setting, home, community and school (Howard et al. 2005). The remaining EIBI study considered EIBI with either the addition of joint attention or symbolic play. Three studies evaluated the Picture Exchange Communication System. One of the PECS studies had two intervention groups; immediate PECS and delayed PECS (Howlin et al. 2007). The design of this study enabled the researchers to assess whether the effects were maintained in those having immediate PECS therapy. Other interventions included video modeling by direct teaching (n=1), the Early Social Interaction project, a parent implemented intervention aimed at increasing communication opportunities within daily routines (n=1), an approach that used parents to implement a 'psycholinguistic and social-pragmatic approach' that included behavioural techniques (n=1), a 'behavioural treatment' intervention focusing on vocabulary acquisition (n=1), and the Autism Preschool Program which offers carers support in behavioural and language development methods (n=1).

Secondary studies

The aim of six reviews/guidelines was to assess the effectiveness of any treatments for children with autism and it was possible to extract from the overall findings specific results pertaining to behavioural interventions. Four reviews assessed the effects interventions of 'behavioural' treatment. Four assessed the effects of various forms of EIBI. Some reviews of SCED studies focussed on particularly types of behavioural intervention that were broadly similar: video (self) modelling (n=3), functional communication training (n=1), interventions based on targeting social skills and communication (n=3).

Comparators

Twelve of the 20 primary studies had variants of an 'eclectic' approach. These were mostly defined as using a combination of approaches, and many included (but not exclusively) ABA approaches. One of these studies had two comparator groups: intensive eclectic therapy and non intensive eclectic therapy. Another of these studies compared low intensity eclectic therapy with low intensity EIBI.

The comparators for the other eight primary studies were: educational software programme (n=1), EIBI (without the interventions joint attention and symbolic play) (n=1), low intensity EIBI (compared to high intensity EIBI) (n=1), unstructured play activities (within an EIBI approach) (n=1), parent directed EIBI (compared to clinic directed EIBI) (n=2), responsive education and prelinguistic milieu teaching (n=1), and no treatment (n=1).

All 21 studies of secondary research (systematic reviews or guidelines) did not specify comparators in their evaluations of behavioural therapies, although conclusions in some of these reviews were based on a synthesis of controlled primary studies with comparators.

Summary of primary study comparators

The majority of the 20 primary studies (n=12) compared different variants of behavioural therapy with a more varied eclectic approach. Six studies had a behavioural control group of some type: one compared EIBI with an educational software programme using a computer, one compared EIBI using either programmes for joint attention or symbolic play skills with EIBI without these additional programmes, one compared high intensity EIBI with low intensity EIBI, one compared a video modelling intervention with an unstructured play behavioural intervention, two compared EIBI delivered in the clinic with EIBI directed by EIBI-trained parents. The remaining two designs included a comparison of ESI with no treatment (n=1), and a comparison of PECS with responsive education and prelinguistic milieu teaching (n=1).

Outcomes

Of the primary studies, most undertook to assess the effects of interventions on a range of skills and behaviours (commonly, cognitive/intellectual functioning, language skills, adaptive functioning, non verbal intelligence, academic achievement such as class placement, and communicative and social skills). Five studies also included results from outcomes not relevant to the scope of the current review. Seven studies assessed the effects of interventions only on aspects of communication and/or language and play. One study restricted the assessment of outcomes to cognitive functioning and behavioural symptoms. Another study assessed the effects of the intervention on a simple learning task, and attention and motivation to continue in the programme.

Of the secondary studies, 10 studies were either non specific about the outcomes assessed in the included studies or evaluated the effects of interventions on overall

functioning and autistic symptoms. Four studies restricted their assessments to social skills and functioning, three solely considered challenging behaviour outcomes, one study assessed the effects of the intervention on both problem behaviour and communication, and three studies assessed intervention effects on a wide variety of outcomes (such as IQ, class placement, behavioural functioning, functional skills, social interaction and play, adaptive functioning).

STUDY QUALITY AND RISK OF BIAS

Level I (systematic reviews, including RCT) studies were mostly of very good (++) or good quality (+): four had ++ quality scores, five had + quality scores and one had a fair (-) quality score.

Of the RCTs (level II evidence), one had a ++ quality score, five had + quality scores and two had – quality scores.

Of the reviews of SCED studies (level III-1 evidence), two had ++ quality scores, seven had + quality scores, and one had – quality scores. Also providing level III-1 evidence, the quasi-randomised study (Kroeger et al. 2007) was of fair (-) quality.

Most of the level III-2 studies had fair quality scores; 10 had fair (–) quality scores and 2 had good (+) quality scores.

EFFECTS OF INTERVENTIONS

The clinical question underpinning this review broadly seeks to determine whether interventions and strategies based on ABA have effects on a wide range of outcomes in people with ASD. As many of the identified studies reported on the multiple outcomes, it was considered more efficient to group results according to type of intervention in the first instance rather than outcome, therefore avoiding repeating critiques of the same studies for different outcomes. The results from the primary studies are reported first as some of these studies were published more recently than the secondary studies and therefore may not have been included in the identified reviews.

Primary studies

Early intensive behavioural intervention studies compared with standard care

A number of studies compared EIBI with a control group of children receiving standard care or an eclectic approach (mostly a mixture of approaches and many also including some ABA approaches). One non randomised experimental study (level of evidence: III-2) of good quality (Eikeseth et al. 2002; Eikeseth et al. 2007) compared EIBI (based on the UCLA treatment model except that no aversives were used) with eclectic treatment designed to reflect best practices for serving children with autism. Intensity of treatment between EIBI and eclectic treatment groups was similar (initially, an average of 28 and 29 hours per week, respectively). Significant differences were reported for the EIBI group at one year follow up in IQ, language and adaptive behaviour when compared with the control group but not in daily living

and socialisation. At 2½ years follow up, significant benefits were found for the EIBI group in IQ, adaptive functioning, communication, daily living skills, aggressive behaviour and socialisation when compared to control. There were no differences reported in socioemotional functioning between groups. Most of the gains appeared before one year follow up. There were also large individual differences in gains in the EIBI group (but none of the demographic variables predicted these individual differences).

Another non randomised controlled study (level of evidence: III-2) of fair quality (Zachor et al. 2007) compared an EIBI programme with an average intensity of 35 hours/week with an eclectic programme (hours not reported). After a year of treatment, the EIBI group had a significant advantage over the control group in language and communication and there was a trend towards a benefit in reciprocal social interaction.

Several non randomised studies (level of evidence: III-2) were identified that compared types of EIBI based at home/community (rather than clinic directed) with types of usual care/eclectic interventions (mostly based at preschool/school or in the community). One study rated as fair quality (Cohen et al. 2006) compared an EIBI programme administered in the community (with an intensity of 35 to 40 hours/week) with eclectic services in public schools (hours per week not reported) in 42 children. Children in the EIBI group had a significant benefit for IQ and adaptive behaviour compared with the control group. No difference between groups was found in language comprehension or non verbal skills. Children having EIBI were more likely to be placed in regular classrooms after three years of treatment. In a study of fair quality by Sheinkopf and Siegel (1998), treatment intensity differed (average of 27 hours for home-based EIBI and 11 hours for school-based eclectic treatment). At an average follow up of 18 months, children receiving EIBI had significantly higher IQ scores and less severe autistic symptoms than children in the control group. However, there were no reported differences between groups on frequency of overall symptoms or proportions remaining autistic. None of the children achieved 'normal functioning'.

Magiati et al (2007) conducted a good quality cohort study which compared home based EIBI in a community setting with a specialist autism-specific school based nursery programme in preschool children. Programme intensity was high for EIBI and school-based groups (32 and 25 hours per week, on average at baseline, respectively). At two year follow up, there were no significant group differences in cognitive ability, language, play or severity of autism. A trend was found for the EIBI group (approaching significance) for daily living skills. However, there were large individual differences in progress with IQ and language level best predicting overall progress. No child was able to attend a regular classroom at the end of treatment without 1:1 support. By contrast, Remington et al's (2007) fair quality cohort study reported a significant benefit at one and two years follow up for children receiving home-based EIBI when compared to those receiving usual care in responding to joint attention, IQ, mental age, daily living skills and a trend for motor skills. No group differences were reported for initiating joint attention, adaptive behaviour (composite), socialisation or communication.

One fair quality study (Eldevik et al. 2006) based in kindergarten/school setting (with treatment administered in separate room) compared EIBI with an eclectic intervention, both delivered at minimal intensity (12.5 and 12 hours/week respectively over 18 months). Participants had both autism and mental retardation. The EIBI group had a significant benefit in IQ gains, language and communication when compared with control. However, there were no significant differences reported between groups for non verbal intelligence, adaptive skills (composite), daily living and socialisation.

Another study also of fair quality (Howard et al. 2005) compared EIBI (administered in multiple settings at an intensity of 25 to 40 hours/week) with two types of control group: intensive eclectic services (1:1 ratio for 30 hours/week in public school classrooms) and a non intensive eclectic early intervention programme (small groups, 15 hours/week, using a combination of methods in community special education classrooms). After 14 months of treatment, children receiving EIBI had significantly higher scores on all skill domains (cognitive skills, non verbal skills, language, adaptive skills) except for motor skills than either of the 2 control groups.

Comparisons of EIBI with programme variations

Some of the primary studies assessing EIBI looked at within-behavioural treatment variations; one study compared EIBI interventions with varying programme content; two studies compared the intensity of EIBI (high intensity vs lower intensity), and two studies compared the means of delivery of EIBI (clinic vs parent guided).

EIBI contrasting programme content

A good quality RCT (level of evidence: II) (Kasari et al. 2006) compared the effects of two specific additions to their EIBI, known as the Early Intervention Program for Infants and Toddlers with Disabilities (EIP). The treatment groups had either additional teaching in joint attention skills or teaching in symbolic play skills in their EIP programme and the control group had EIP alone with intensive hours and nearly 1:1 staff ratios. Children in the joint attention plus EIP intervention initiated significantly more showing and responsiveness to joint attention on the structured joint attention assessment and more child-initiated joint attention in the mother-child interaction. The children in the play plus EIP group showed more diverse types of symbolic play in interaction with their mothers and higher play levels on both the play assessment and in interaction with their mothers.

EIBI studies contrasting programme intensity

The intensity of behavioural interventions is an important factor in the determination of effectiveness and was considered by two primary studies. A cohort study (level of evidence: III-2) (Reed et al. 2007) rated as fair quality compared the effects of 3 different types of high intensity with low intensity EIBI on a variety of outcomes in preschool children after 9 to 10 months of home based treatment. As the numbers of participants in each of the high intensity programmes (Lovaas, Verbal Behaviour or CABAS) in the Reed et al (2007) study are insufficient to meet the inclusion criteria of this report, results are reported for the three high intensity programmes combined. There were significantly stronger gains in the high intensity EIBI group (average 30

hours/week) educational functioning relative to those in the low intensity group (average 13 hours/week) but gains in adaptive behaviour were smaller and not significantly different between groups. The difference between groups in intellectual functioning did not reach statistical significance. There was also no evidence of a change in the rating of autism severity across groups. Regression analysis indicated that there was an inverse relationship between the temporal input and the gains in the high intensity group, suggesting that the original requirement of 40 hours per week suggested by Lovaas (1987) may not be optimal. In this study, there were diminishing returns after an intensity of 20 hours per week.

A randomised controlled trial (level of evidence: II) (Smith et al. 2000) of good quality (level of evidence: II) also compared the intensity of EIBI but with different implementation; high intensity clinic guided EIBI was compared with lower intensity parent directed EIBI. The study compared an average of 24.5 hours per week of clinic directed EIBI with a lower intensity programme of EIBI directed by trained parents (weekly hours of training not reported) over a period of 4 to 5 years. At follow up, the intensive treatment group outperformed the parent training group on measures of intelligence, visual spatial skills, language and academics, though not adaptive functioning or behaviour problems. The intensively treated children also had less restrictive school placements. There was, however, variation in the gains made by the children with some children making very modest gains. Moreover, because the method of delivery of the behavioural therapy also varied (clinic vs parent directed), it is not clear whether the differences between groups was due to variation in the intensity (hours of EIBI the child received) or the means of delivery (clinic or parent-directed) of the programme.

EIBI studies contrasting programme delivery

The means of delivery of the behavioural therapy may also be a factor influencing the effectiveness of treatment. Two good quality RCTs (level of evidence: II) (Sallows and Graupner 2005; Smith et al. 2000) compared clinic directed with parent directed EIBI.

The aim of Sallows and Graupner's (2005) study was to determine whether a community based programme operating without the resources, support and supervision of a university centre could implement an EIBI programme and achieve similar results. After two to four years of treatment, cognitive, language, adaptive, social and academic measures were similar for both the clinic directed and parent directed EIBI groups. Children in both clinic and parent directed groups were treated intensively (average of 39 hours/week and 32 hours/week, respectively, in year 1), although the parent directed group received much less supervision. There was also variation in the gains made by children within both groups. The authors divided all participants into 'rapid' and 'moderate' learners post hoc in an attempt to assess patterns of improvement and look at overall predictors of achievement. Those in the rapid group (48%) showed dramatic increases in cognitive functioning (from a mean IQ of 55 to a mean IQ of 104) and social skills and were able to succeed in regular education classrooms. Low IQ (below 44) and absence of language (no words at 36

months) predicted limited progress whereas the rate of learning, imitation and social relatedness predicted favourable outcomes.

As described in the section on programme intensity, Smith et al's (2000) good quality RCT also compared clinic directed with parent directed behavioural treatment but the parent group had less intensive therapy. The benefits found in this study for the intensive clinic directed EIBI group when compared to the parent directed group may be related either to the less intensive hours in the latter group or the mode of delivery of the programme or both.

Picture Exchange Communication System

Three primary studies (one reported in two publications) assessed the effects of the Picture Exchange Communication System, a programme that teaches children how to interact with others by exchanging pictures, symbols, photographs or real objects for desired items (Carr and Felce 2007; Howlin et al. 2007; Yoder and Stone 2006a; Yoder and Stone 2006b). The goals of PECS are specific: to identify objects that may serve as stimuli for each child's actions and to learn responses to simple questions with multi-picture systems. This behavioural programme uses ABA to teach functional communication.

One of the two RCTs (level of evidence: II) (Howlin et al. 2007) compared a group of elementary school children receiving immediate PECS or delayed PECS with elementary school children receiving standard care. In this good quality study, PECS was implemented during a five month period for the immediate treatment group until Time 2, the delayed treatment group then had five months of PECS treatment until Time 3 and assessments at Time 3 measured the immediate effects of PECS in the delayed group and the maintenance effects in the immediate treatment group. Rates of initiations and PECS usage increased significantly after treatment compared to the standard care group but were not maintained at Time 3 for the immediate treatment group. There were no group differences in frequency of speech, ADOS ratings (communication and reciprocal social interaction) and language scores.

A non randomised experimental study (level of evidence: III-2) of fair quality (Carr and Felce 2007) also effectively compared PECS with no PECS treatment, using an instrument especially designed to record communication outcomes. Children aged between 3 and 7 years were allocated to either PECS plus eclectic treatment or eclectic treatment alone, based on whether they were within a 50 mile radius of researchers or not. Children receiving PECS had a significant benefit in frequency of child to adult initiations, frequency of linguistic communications, percentage of adult responses given to child initiated communications and percentage of child responses to adult initiated communications. There was no reported difference in the frequency of initiations giving an opportunity for child response and the frequency of adult to child initiations with no opportunity to respond was significantly higher for children receiving control.

The other PECS study was a very good quality RCT (level of evidence: II) (Yoder and Stone 2006a; Yoder and Stone 2006b). It compared two communication intervention approaches that address the intent to communicate prior to targeting spoken communication, PECS and 'Responsive Education and Prelinguistic Milieu Teaching'

(RPMT). Outcomes were measured in preschool children after six months of treatment and again six months after treatment finished. There was strong growth on measures of spoken communication at 12 months follow up for both treatments and no significant differences were reported between groups. However, when assessments were made immediately after treatment ceased, PECS was more successful than RPMT in increasing the number of nonimitative spoken communication acts and the number of different nonimitative words used. Considering all measurement periods, growth rate of the number of nonimitative words was faster in the PECS group than in the RPMT group for children who began treatment with relatively high object exploration. However, growth rate was faster in the RPMT group than in the PECS group for children who began treatment with relatively low object exploration. For children who began treatment with at least some initiating joint attention, RPMT facilitated the frequency of generalised turn taking and initiating joint attention more than did the PECS. In contrast, the PECS facilitated generalised requests more than the RPMT in children with very little initiating joint attention prior to treatment.

Other interventions

One good quality RCT (level of evidence: II) compared the Autism Preschool Program (which uses a variety of behavioural and language development methods directed by parents and day care staff) with standard care at day care centres (Jocelyn et al. 1998). Language development was significantly greater for children in the APP group. However, blind assessment by a psychologist of autistic symptoms indicated that these symptoms did not improve over time and did not differ between groups.

An RCT (level of evidence: II) of fair quality (Moore and Calvert 2000) compared the effects of a behavioural programme alone with the same programme using sensory reinforcement using educational software in preschool children. The addition of the computer increased the number of unknown words learned, increased attention to task and increased children's motivation to continue in the programme but the fair quality study was very small (7 in each group) and follow up very short (1 week).

A fair quality RCT (level of evidence: II) (Drew et al. 2002) compared a group directed by parents trained in a psycho-linguistic and social-pragmatic approach (using behavioural management techniques) with local services (where a mixture of approaches were used, including ABA). The children were required to be less than two years of age. There were no reported differences after treatment between groups in non verbal IQ, symptom severity or parent stress. A trend towards a greater benefit for the experimental group in some language abilities was reported but groups were not equivalent at baseline.

A quasi randomised controlled trial (level of evidence: III-1) of fair quality (Kroeger et al. 2007) compared direct teaching using a video-modelling format to teach play and social skills with unstructured play without direct instruction. Both groups had a similar staff to student ratio, reinforcement and behavioural management for inappropriate behaviour. Groups met regularly three times a week for five weeks. Both groups improved in their prosocial behaviours. The direct teaching group made

significantly greater gains in initiating behaviours, responding behaviours and interacting behaviours.

Finally, a fair quality non randomised experimental study (level of evidence: III-2) (Wetherby and Woods 2006) compared the effects of the Early Social Interaction Project (ESI) (a programme designed to apply the recommendations of the National Research Council, UK) with a no treatment group on social communication outcomes. Communicative means and play were similar between groups after ESI treatment. However, children receiving ESI had significantly greater gains in social signals, rate of communicating, communicative functions and understanding than children not receiving ESI.

Secondary studies

Eleven of the 21 secondary studies assessed the effects of behavioural interventions (including EIBI) on global autistic symptoms rather than specific behaviours, 3 assessed video modelling, 3 assessed social skills interventions and 4 assessed the effects of behavioural interventions on challenging behaviour.

Reviews of interventions assessing global improvement

Of the 11 reviews assessing global improvement, 10 were level I systematic reviews (Bassett et al. 2000; Burrows 2004; Chorpita et al. 2002; Doughty 2004; Finch and Raffaele 2003; Ludwig and Harstall 2001; McGahan 2001; Parr 2007; Roberts and Prior 2006; Scottish Intercollegiate Guidelines Network 2007) and one was a level III-1 review of SCED studies (Smith 1999). All reported positive effects of behavioural interventions on overall functioning, mostly in preschool children. However, eight of these secondary studies emphasised that results from the studies were inconsistent and their evidence synthesis indicated that no single programme had been identified that was more effective than any other programme. Concerns noted included that the extent of the improvement varied across studies, and that there was variation in response within groups which could not be explained by demographic factors. Gaps in evidence reported included that there was insufficient evidence to determine the duration and intensity of treatment, long term effects were unknown, as was the effectiveness of the intervention for older children.

It is important to note that many of these reviews predated the more recent primary studies described in the previous section. The most recent of these reviews assessing effects on global autistic symptoms (published in 2006 and 2007) (Parr 2007; Roberts and Prior 2006; Scottish Intercollegiate Guidelines Network 2007) gave qualified support for behavioural interventions using ABA techniques. The very good quality review published in BMJ Clinical Evidence 2007 (Parr 2007) stated that there was low quality evidence that ABA type programmes might improve language function and IQ when compared to eclectic programmes but there was insufficient evidence for the other programmes using behavioural techniques, such as the Autism Preschool Program and PECS (although primary studies on PECS have been published since this review was completed). An Australian review of good quality by Roberts and Prior (2006) of the most effective models of practice for children with ASD also acknowledged that early behavioural intervention produces positive

outcomes for children with ASD but the variation in the children, families, therapists, contexts and methods makes it difficult to reach definitive conclusions. The recent very good quality SIGN guideline (2007) made an A grade² recommendation that the Lovaas (1987) programme should not be presented as an intervention that will lead to normal functioning. It made a B grade³ recommendation that behavioural interventions should be considered to address the wide range of specific behaviours in children and young people with ASD, both to reduce symptom frequency and severity and to increase the development of adaptive skills. However, the guideline did not identify the components of a successful behavioural programme.

The other secondary studies were reviews of small SCED studies (level of evidence III-1) and either used specific types of behavioural intervention, such as video modelling or targeted specific behaviours.

Reviews of video modelling interventions

Three reviews (of good or very good quality) assessed the effects of video modelling and/or video self modelling, mostly on social and communication skills, functional behaviour and challenging behaviour (Ayres and Langone 2005; Bellini and Akullian 2007; Delano 2007). All three reviews found that video modelling or video self modelling had positive effects on these outcomes but noted that the critical features of the intervention(s) were not identified. Two of the reviews confirmed that there was a moderate effect of the video modelling intervention on maintenance and generalisation of skills and behaviour. One review noted that it was unclear how video modelling compared to other programmes targeting these behaviours.

Reviews of interventions assessing social skills

Three reviews (level of evidence III-1) assessed the effects of all types of 'social skills' interventions on collateral skills and social behaviours (Bellini et al. 2007; Matson et al. 2007; McConnell 2002). Two of these were qualitative reviews where the researchers relied on the conclusions drawn by the studies' authors to determine treatment effectiveness. One other review of good quality (Bellini et al. 2007) attempted to synthesise the studies quantitatively. This review reported a low to questionable treatment effect for social skills interventions, a low to questionable generalisation effect and a moderate maintenance effect leading to the conclusion that social skills interventions were minimally effective. There was no difference in relative effectiveness by different types, features of the interventions, age group or individual versus group except for location. Interventions in classrooms were more

²That it is based on at least one high-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias (directly applicable to the target population), or a body of evidence consisting principally of well conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias (directly applicable to the target population, and demonstrating overall consistency of results) (<http://www.sign.ac.uk/guidelines/fulltext/50/annexb.html>).

³That is, based on either a body of evidence including high quality systematic reviews of case control or cohort or studies, high quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal (directly applicable to the target population and which demonstrate overall consistency of results), or extrapolated evidence from well conducted or high quality meta-analyses, systematic reviews of RCTs, or RCTs with a low or very low risk of bias.

effective than those delivered in 'pull out' locations. There was insufficient evidence in the reviews to distinguish between the types and features of these interventions.

Reviews of interventions assessing challenging behaviour, and use of functional communication training

Four reviews of SCED studies (level of evidence III-1) assessed the effects of behavioural interventions on challenging behaviour. One of these assessed the effects of functional communication training (FCT) on both challenging behaviour and communication (Mancil 2006) and the other three targeted challenging behaviour alone (Campbell 2003; Horner et al. 2002; Machalicek et al. 2007). Settings in the majority of the included studies were the clinic or classroom.

The first review (Mancil 2006), rated as good quality, reported that FCT (preceded by functional behaviour analysis) implemented in a clinic setting decreased challenging behaviour and increased communication, but there was insufficient information about long term follow up, maintenance and generalisation. It noted that the majority of research of FCT in this context is clinically based and focuses on one communication method. The other three reviews assessed the effects of behavioural interventions without specifying the specific nature of these interventions. The authors reported that the interventions reduced challenging behaviour from between 76% to 90%. However, one review of good quality (Horner et al. 2002) noted that there was little evidence for generalisation and maintenance of intervention effects.

One of the three reviews (level of evidence III-1) relating to interventions for challenging behaviour (Machalicek et al. 2007), which was of fair quality and was limited to school-based studies, found that functional behavioural assessment methods (of any type) were used in half of the studies included in the review, but most (73%) of the interventions reported equally positive findings.

The other two reviews of good/very good quality (Campbell 2003; Horner et al. 2002) found that functional behaviour assessment (FBA) prior to the implementation of behavioural interventions (across settings) increased effectiveness. The very good quality review by Campbell et al (2003) which employed hierarchical multiple regression analyses reported that FBA generally contributed to intervention success, but also found that those employing experimental functional analysis (EFA) had the most impact compared with other functional assessment methods involving indirect or descriptive methods. EFA is the most methodologically rigorous type of FBA and involves undertaking a number of structured observations under several standardised conditions which are introduced and withdrawn systematically. Notably, no other participant, treatment, or experimental variables contributed to efficacy in the regression equation.

DISCUSSION

The majority of primary studies identified by the current review considered early intensive behavioural interventions clearly based on ABA principles contrasted with standard care programmes.

Comparison of early intensive behavioural intervention with standard care

A larger number of studies compared behavioural treatment with eclectic treatment or standard care that was available in the community for autistic children. It is possible that the eclectic care arms of the included studies varied in the content, delivery and intensity of their programmes but it is useful to compare the findings of the studies to see if patterns can be determined. Some of the studies attempted to replicate the number of hours per week recommended by Lovaas (1987) (35 to 40 hours per week) in the Young Autism Project but most averaged 25 to 30 hours per week. A variety of outcomes were measured from one to three years follow up. Results were not always consistent and the extent of improvement varied across the studies.

Only four studies (all non randomised experimental or cohort studies) attempted to broadly match intensity between behavioural and eclectic/usual care arms. Of the three considering treatments of high intensity averaging between 25-40 hours per week, two (of good and fair quality respectively) reported benefits for children having behavioural treatment in cognitive development/IQ, adaptive functioning and language development at 12-14 month, and 2 ½ year follow-up (Eikeseth et al. 2002; Eikeseth et al. 2007; Howard et al. 2005). The other study (Magiati et al. 2007) rated as good quality found no group differences after two years in cognitive ability, language, play or severity of autism, although a trend was found for the EIBI group (approaching significance) for daily living skills. Finally, a fair quality study comparing less intensive behavioural treatment with eclectic treatment (average of 12 hours a week) found benefits for the behavioural group in IQ, language, communication but not in nonverbal intelligence, adaptive functioning, daily living or socialisation (Eldevik et al. 2006). These results are consistent with the conclusions of two recent high quality systematic reviews. BMJ Clinical Evidence concluded that ABA may improve IQ and language skills compared with eclectic treatment (a recommendation based on low quality evidence) (Parr 2007). The review conducted by SIGN (Scottish Intercollegiate Guidelines Network 2007) gave a qualified recommendation that behavioural interventions should be considered to address a wide range of specific behaviours in children and young people with ASD.

This potential benefit of behavioural treatment when compared with usual care or mixed approaches must be treated with caution as results in similar studies were not consistent and many of the studies noted that there was a large variation in individual response within the treated groups. Several studies attempted to ascertain the factors that predicted response but results from these analyses were not always consistent and/or conclusive.

Comparing variations of EIBI programmes

There is clear evidence that behavioural therapy produces positive effects in young children with ASD. What remains to be identified are the particular features, intensity and duration of behavioural therapy that give optimal results.

One RCT (Kasari et al. 2006) of good quality reported that the addition of joint attention and play skills interventions to a standard early intervention programme resulted in greater joint engagement, joint attention and functional play skills than the control group which had similar intensity treatment, thus suggesting that the content of the intervention was responsible for the benefit. This finding needs to be confirmed in further research studies.

The three primary studies that attempted to compare intensity and mode of delivery of treatment did not reach clear conclusions about optimal treatment. Although one study (Reed et al. 2007) found that children treated for an average of 30 hours per week achieved stronger gains in educational functioning than those treated for an average of 13 hours per week, there were no reported differences for other types of functioning such as adaptive functioning and changes in autism severity. Moreover, the authors found that there was an inverse relationship as hours increased in the intensively treated group. This study was non randomised and of fair quality and the possibility of bias cannot be excluded. Another good quality RCT (Smith et al. 2000), which reported more benefits for children treated intensively for an average of 25 hours per week compared to those having less intensive behavioural treatment (hours not reported), had a variable source of delivery of the intervention between the groups (clinic staff versus parents who had received some training). This means that either mode of delivery or intensity of treatment could be associated with the significant differences in intellectual functioning, visual spatial skills, language and academic achievement. The third study (Sallows and Graupner 2005), a good quality RCT, found no differences between a clinic directed group with intensive EIBI delivery (39 hours/week) and a slightly less intensive (32 hours/week) parent directed group (receiving relatively less supervision from clinic staff). Overall, there is insufficient evidence to determine the optimal intensity of behavioural therapy and whether mode of delivery (clinic directed vs parent directed) influences achievements.

Future research should concentrate on both defining the specific features of behavioural treatment (intensity, duration, settings) that lead to optimal gains and determining the predictors of response so that the effectiveness of treatment can be enhanced through the targeting of individuals who will most benefit.

Behavioural communication interventions

The results from the studies focusing on communication outcomes varied. Three studies investigated the effects of PECS (Carr and Felce 2007; Howlin et al. 2007; Yoder and Stone 2006a; Yoder and Stone 2006b) on functional communication skills and one RCT of fair quality investigated the effects of a different type of communication intervention (Drew et al. 2002). Two of the PECS studies included

older non verbal children with autism, mostly of primary (elementary) school age. These studies found a benefit for two sessions of PECS in these children but outcomes and results varied. A good quality RCT (Howlin et al. 2007) found a benefit for rates of initiation and usage of PECS (but not for frequency of speech, ADOS scores and language) and the other found a benefit for a range of communicative interactions between children with ASD and the teaching staff. Although some benefits were found for PECS in these studies, there was no evidence that these benefits were maintained after treatment ceased. The Howlin et al (2007) RCT was designed to measure maintenance of effects and found that an average of 10 months after treatment ceased, there were no differences between children having PECS and those in the control group. The other study (Carr and Felce 2007), of fair quality, was not designed to measure maintenance of effects and so it is unknown whether the benefits found were maintained after treatment.

The third PECS study, a very good quality RCT, compared PECS with Responsive Education and Prelinguistic Milieu Teaching (RPMT) in preschool children (Yoder and Stone 2006a; Yoder and Stone 2006b). There was no significant difference between groups six months after treatment finished and results from both groups indicated strong growth on both measures of spoken communication. However, communication outcomes significantly favoured PECS immediately after treatment was finished suggesting that PECS had a more rapid effect on spoken communication than did RPMT. This finding can be further qualified: relative treatment efficacy varied by initial object exploration. The initial advantage of PECS for children who began treatment with high object exploration and the initial advantage of RPMT for children who began treatment with relatively low object exploration levels emphasises the importance of targeting and considering object play skills. For both treatments, effects were maintained after treatment ceased, in contrast to the other studies. The finding of relative effects has implications for the individualising of treatment for children to maximise communication outcomes. In summary, the included studies all found benefits for PECS in preschool and primary (elementary) school children with ASD but these effects were not maintained in all studies after treatment stopped. More research is needed to determine whether the benefits of PECS can be maintained, particularly when taught to primary (elementary) school children with ASD.

The other study used a different type of communication intervention, a psycholinguistic and social pragmatic approach (Drew et al. 2002). This RCT found no benefits for the experimental intervention.

Interventions for challenging behaviour

Behavioural interventions have also been used successfully to reduce challenging behaviour, with clear evidence of a potential overall benefit (ranging from 76% to 90%) in the secondary studies specifically measuring this outcome. However, there was little evidence that effects were generalised and maintained. Studies have generally not determined what participant, treatment or experimental characteristics identify the more successful behavioural approaches in reducing challenging

behaviour in people with autism. High quality reviews of SCED studies have identified one feature as predictive of intervention success: the use of functional behaviour assessment (FBA) prior to the intervention, and particularly the more rigorous form of FBA known as experimental behaviour analysis. The findings of one recent review of SCED studies (Campbell 2003) suggested that functional communication training preceded by FBA reduces challenging behaviour and increases communication, though the generalisability of these studies to more natural environments is limited by their being conducted predominantly in clinic settings. The social validity of behavioural interventions for challenging behaviour needs to be evaluated.

Other behavioural approaches

There was insufficient evidence to recommend other behavioural approaches that could be distinguished from EIBI. One good quality RCT (Jocelyn et al. 1998) found that there was a benefit for children receiving the Autism Preschool Program in their language development but blind assessment of autistic symptoms did not find evidence of a difference in these other outcomes. The addition of a computer to a behavioural programme in an RCT (Moore and Calvert 2000) reported a benefit for the number of nouns learned and attention to task but the methodology was poor and the sample very small.

The effects of interventions on communication, play and social skills were investigated by two other primary studies of fair quality (Kroeger et al. 2007; Wetherby and Woods 2006). Using a quasi-randomised, controlled design, direct teaching using a videomodelling format (compared to unstructured play) found benefits for social skills (Kroeger et al. 2007). The benefits of video modelling have been confirmed by three reviews of SCED studies in this domain (Ayres and Langone 2005; Bellini and Akullian 2007; Delano 2007) but concern was expressed that the critical features of the interventions were not clearly identified and thus specific recommendations could not be made. The three reviews (Bellini et al. 2007; Matson et al. 2007; McConnell 2002) that assessed the benefits of social skills interventions of various types found qualified support for these interventions and attempted to categorise the different types but there was little quantitative analysis. In the only review that provided quantitative analysis (Bellini et al. 2007), there was a low to questionable treatment effect, low to questionable generalisation effect and a moderate maintenance effect. These findings need confirmation in further research and the specific features responsible for the effectiveness of programmes need to be defined and standardised. The other primary study addressing social skills development (Wetherby and Woods 2006) was non-randomised and had significant flaws in design. It assessed the effects of ESI, a programme based on NRC recommendations in the UK compared to no treatment. The benefits found for ESI, social signals, rate of communicating, communicative functions and understanding, also need to be confirmed in trials with a more rigorous design.

SUMMARY AND CONCLUSIONS

This systematic review considered the evidence for the effectiveness of interventions grounded in applied behavioural analysis for people with autism spectrum disorder.

From 1517 articles identified by the search strategy, 43 publications were identified as eligible for appraisal and inclusion in the review. These were: 21 systematic reviews or evidence-based guidelines (10 reviews of either exclusively SRs and RCTs or broader inclusion criteria and 11 reviews of lower order evidence), and 20 primary studies (8 RCTs, one quasi randomised study, 3 cohort studies and 8 non-randomised experimental studies).

There was consistent evidence across a range of studies of reasonable quality and in different settings that behavioural approaches (predominantly grounded in ABA principles) can produce positive treatment outcomes in young (particularly pre-school) children with ASD. Further, of the few studies identified that compared ABA with eclectic/usual care approaches of similar intensity, the majority found greater benefit for the ABA group in terms of language skills, IQ and adaptive behaviour, although there was wide variation in individual responses. Whilst the evidence base is small, there is emerging evidence that behavioural approaches appear to hold the most promise for providing positive outcomes for children with ASD compared to eclectic programmes of similar intensity. This conclusion is consistent with several recent high quality systematic reviews which cautiously recommended the use of behavioural approaches for this population.

Identifying patterns in the study results was limited by the heterogeneity of the evidence base, reflected in varying intervention approaches, intensity of treatment, comparators, study settings, sample characteristics (particularly age of participants) and outcomes. As more than one variable often varied between comparators (such as treatment type, intensity and delivery), it was difficult to determine the precise cause of any group differences identified.

The majority of primary studies evaluated variations on early intensive behavioural intervention programmes. Evidence from two of three studies which compared interventions of similarly high intensity suggests that EIBI can improve language skills, IQ and adaptive behaviour, although individual responses were highly variable. From two primary studies comparing programmes of *varying* intensity (keeping source of delivery constant), there was insufficient evidence to recommend the optimal number of intervention contact hours, although one study found that effectiveness diminished beyond 20 hours per week. Comparisons between interventions delivered by clinic staff and those of similar intensity directed by parents (with some specialist training or supervision provided) did not reveal differences in outcomes for participants with ASD.

Three studies investigating Picture Exchange Communication System found positive effects for preschoolers and primary school children with ASD, although these were not necessarily maintained beyond treatment. One study found differential results for two communication approaches, suggesting that treatment choice should take into account the abilities of participants.

There was generally consistent evidence from a primary group study and three reviews of SCED studies that video modelling can lead to positive impacts for children with ASD. Three secondary studies found qualified support for social skills interventions generally. There was insufficient evidence to determine the effects of a range of other behavioural intervention approaches evaluated in single studies.

Four secondary studies provided evidence that behavioural interventions can reduce challenging or problem behaviour from between 76% to 90%, although it is not known whether these effects are maintained or generalised.

Whilst there was some variation in findings relating to functional behaviour analysis, two of the better quality systematic reviews found that FBA conducted prior to an intervention increases its effectiveness, with one review providing evidence that experimental functional analysis was the most effective FBA approach of those considered.

The current research base was limited by variability of results between studies and between individuals. Further controlled experimental research is needed to investigate the characteristics, intensity and duration of behavioural interventions that lead to the most positive impact on outcomes for people with ASD (and their families). Whilst the current review identified particular intervention programmes and strategies that can be effective, further work is needed to determine the critical features that are both necessary and sufficient components of an effective intervention. A notable limitation of the evidence base is the lack of studies comparing ABA-based interventions with high quality non ABA-based interventions also delivered by experts.

Additional research into the characteristics of the person with ASD which best predict response would also assist in directing behavioural interventions toward individuals who are most likely to benefit or to benefit more significantly. Research in this field considered by the current review has tended to focus on young children, and investigating the use of behavioural approaches for assisting older children and adults with ASD is a research gap deserving of further attention.

Evidence identified in this review is broadly consistent with the following recommendations of the New Zealand ASD Guideline (Ministries of Health and Education 2008) that:

- “decisions about the type of intervention and the degree of intensity should be informed by a skilled team and reflect the child’s developmental stage, characteristics, teaching goals and family preferences” (Recommendation 3.1.3);
- “educational interventions should incorporate principles of positive behaviour support, particularly a focus on understanding the function of the child’s behaviour” (Recommendation 3.2.5.2);
- “behaviour management techniques should be used to intervene with problem behaviours” (Recommendation 4.3.4);
- “all behavioural interventions should be of good quality and incorporate . . . functional assessment” (Recommendation 4.3.5).

The current review's findings should be considered in conjunction with those of an independent systematic review conducted in parallel for the Ministries that included SCED primary studies. It is hoped that the conclusions from these overlapping streams of evidence complement and enrich each other to provide a comprehensive account of the evidence base.

The findings from the current review extends and strengthens the ASD Guideline's (Ministries of Health and Education 2008) recommendations relating to ABA. It identifies emerging evidence for superior benefits of behavioural approaches over eclectic/standard care approaches in education, treatment and managing problem behaviour for people with ASD in their early childhood. However this finding should be treated with caution as results were not always consistent, the number of studies where potential confounding factors were controlled were few, and responses between individuals were highly variable. Future research is needed to maximise treatment success and the direction of available resources by identifying the specific characteristics of behavioural treatment and the individuals receiving it that lead to best results.

Development and refinement of interventions for people on the autism spectrum as well as experimental investigations of treatment effectiveness are active areas of research interest. It is recommended that the findings of this report are reviewed and updated as relevant high quality evidence emerges.

REFERENCES

- Ayres, K.-M., & Langone, J. (2005). Intervention and Instruction with Video for Students with Autism: A Review of the Literature. *Education and Training in Developmental Disabilities*, 40, 183-196.
- Bassett, K., Green, C. J., & Kazanjian, A. (2000). Autism and Lovaas treatment: A systematic review of effectiveness evidence. Vancouver: BC Office of Health Technology Assessment, Centre for Health Services and Policy Research, University of British Columbia.
- Bellini, S., & Akullian, J. (2007). A Meta-Analysis of Video Modeling and Video Self-Modeling Interventions for Children and Adolescents With Autism Spectrum Disorders. *Exceptional Children*, 73, 264-287.
- Bellini, S., Peters, J.-K., Benner, L., & Hopf, A. (2007). A Meta-Analysis of School-Based Social Skills Interventions for Children With Autism Spectrum Disorders. *Remedial and Special Education*, 28, 153-162.
- Broadstock, M., & Doughty, C. (2003). The effectiveness of pharmacological therapies for young people and adults with Autism Spectrum Disorder (ASD), *NZHTA Report 6(1)*. Christchurch, NZ: New Zealand Health Technology Assessment, Dept. of Public Health and General Practice, Christchurch School of Medicine and Health Sciences.
- Burrows, K. (2004). Early intervention for children with autism. *Paediatrics and Child Health*, 9, 267-277.
- Campbell, J. M. (2003). Efficacy of behavioral interventions for reducing problem behavior in persons with autism: A quantitative synthesis of single-subject research. *Research in Developmental Disabilities*, 24, 120-138.
- Carr, D., & Felce, J. (2007). Brief report: Increase in production of spoken words in some children with autism after PECS teaching to phase III. *Journal of Autism and Developmental Disorders*, 37, 780-787.
- Chorpita, B. F., Yim, L. M., Donkervoet, J. C., Arensdorf, A., Amundsen, M. J., McGee, C., et al. (2002). Toward large-scale implementation of empirically supported treatments for children: A review and observations by the Hawaii empirical basis to services task force. *Clinical Psychology: Science and Practice*, 9, 165-190.
- Cohen, H., Amerine-Dickens, M., & Smith, T. (2006). Early intensive behavioral treatment: Replication of the UCLA model in a community setting. *Journal of Developmental and Behavioral Pediatrics*, 27, S145-S155.
- Delano, M.-E. (2007). Video Modeling Interventions for Individuals with Autism. *Remedial and Special Education*, 28, 33-42.
- Diggle, T., McConachie, H. R., & Randle, V. R. L. (2002). Parent-mediated early intervention for young children with autism spectrum disorder. *Cochrane Database of Systematic Reviews*.

Doughty, C. (2004). What is the evidence for the effectiveness of behavioural and skill-based early intervention in young children with Autism Spectrum Disorder (ASD)? NZHTA Tech Brief Series 3(1). Christchurch, NZ: New Zealand Health Technology Assessment, Dept. of Public Health and General Practice, Christchurch School of Medicine and Health Sciences.

Drew, A., Baird, G., Baron-Cohen, S., Cox, A., Slonims, V., Wheelwright, S., et al. (2002). A pilot randomised control trial of a parent training intervention for pre-school children with autism: Preliminary findings and methodological challenges. *European Child and Adolescent Psychiatry*, 11, 266-272.

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2002). Intensive behavioral treatment at school for 4- to 7-year-old children with autism: A 1-year comparison controlled study. *Behavior Modification*, 26, 49-68.

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2007). Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: A comparison controlled study. *Behavior Modification*, 31, 264-278.

Eldevik, S., Eikeseth, S., Jahr, E., & Smith, T. (2006). Effects of low-intensity behavioral treatment for children with autism and mental retardation. *Journal of Autism and Developmental Disorders*, 36, 211-224.

Finch, L., & Raffaele, C. (2003). Developing expert practice. Intensive behavioural intervention for children with autism: a review of the evidence. *Occupational Therapy Now*, 5, 20-23.

Horner, R. H., Carr, E. G., Strain, P. S., Todd, A. W., & Reed, H. K. (2002). Problem Behavior Interventions for Young Children with Autism: A Research Synthesis. *Journal of Autism and Developmental Disorders*, 32, 423-446.

Howard, J. S., Sparkman, C. R., Cohen, H. G., Green, G., & Stanislaw, H. (2005). A comparison of intensive behavior analytic and eclectic treatments for young children with autism. *Research in Developmental Disabilities*, 26, 359-383.

Howlin, P., Gordon, R., Pasco, G., Wade, A., & Charman, T. (2007). The effectiveness of Picture Exchange Communication System (PECS) training for teachers of children with autism: A pragmatic, group randomised controlled trial. *Journal of Child Psychology and Psychiatry*, 48, 473-481.

Jocelyn, L. J., Casiro, O. G., Beattie, D., Bow, J., & Kneisz, J. (1998). Treatment of children with autism: A randomized controlled trial to evaluate a caregiver-based intervention program in community day-care centers. *Journal of Developmental & Behavioral Pediatrics*, 19, 326-334.

Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: a randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*, 47, 611-620.

Kroeger, K. A., Schultz, J. R., & Newsom, C. (2007). A comparison of two group-delivered social skills programs for young children with autism. *Journal of Autism and Developmental Disorders*, 37, 808-817.

- Logan, L., Romeiser, L., Hickman, R., Harris, S., & Heriza, C. (2008). Single-subject research design: recommendations for levels of evidence and quality rating. *Developmental Medicine & Child Neurology*, 50, 99-103(5).
- Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology*, 55, 3-9.
- Ludwig, S., & Harstall, C. (2001). Intensive intervention programs for children with autism, *Health Technology Assessment 8: Series B*. Edmonton: Alberta Heritage Foundation for Medical Research (AHFMR).
- Machalicek, W., O'Reilly, M. F., Beretvas, N., Sigafoos, J., & Lancioni, G. E. (2007). A review of interventions to reduce challenging behavior in school settings for students with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 1, 229-246.
- Magiati, I., Charman, T., & Howlin, P. (2007). A two-year prospective follow-up study of community-based early intensive behavioural intervention and specialist nursery provision for children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 48, 803-813.
- Mancil, G. (2006). Functional Communication Training: A Review of the Literature Related to Children with Autism. *Education and Training in Developmental Disabilities*, 41, 213-224.
- Matson, J.-L., Matson, M.-L., & Rivet, T.-T. (2007). Social-Skills Treatments for Children with Autism Spectrum Disorders: An Overview. *Behavior Modification*, 31, 682-707.
- McConnell, S. R. (2002). Interventions to Facilitate Social Interaction for Young Children with Autism: Review of Available Research and Recommendations for Educational Intervention and Future Research. *Journal of Autism and Developmental Disorders*, 32, 351-372.
- McGahan, L. (2001). Behavioural interventions for preschool children with autism, *Technology Report, 18*. Ottawa: Canadian Coordinating Office for Health Technology Assessment (CCOHTA).
- Ministries of Health and Education (2007). Request for Tender (RFT). Review of published research on Applied Behaviour Analysis (ABA) interventions for people with Autism Spectrum Disorder (ASD). Wellington, New Zealand.
- Ministries of Health and Education (2008). New Zealand Autism Spectrum Disorder Guideline. Wellington.
- Moore, M., & Calvert, S. (2000). Brief report: vocabulary acquisition for children with autism: teacher or computer instruction. *Journal of Autism & Developmental Disorders*, 30, 359-62.
- National Health and Medical Research Council (2008). NHMRC additional levels of evidence and grades for recommendations for developers of guidelines. Pilot program 2005-2007 NHMRC.

- New Zealand Guidelines Group (2001). Handbook for the preparation of explicit evidence-based clinical practice guidelines. Wellington: New Zealand Guidelines Group.
- Parr, J. (2007). Autism: early multidisciplinary intervention: applied behavioural analysis, *BMJ Clinical Evidence*.
- Prizant, B. M., & Wetherby, A. M. (1998). Understanding the continuum of discrete-trial traditional behavioral to social-pragmatic developmental approaches in communication enhancement for young children with autism/PDD. *Seminars in Speech & Language*, 19, 329-52; quiz 353; 424.
- Reed, P., Osborne, L.-A., & Corness, M. (2007). Brief Report: Relative Effectiveness of Different Home-Based Behavioral Approaches to Early Teaching Intervention. *Journal of Autism and Developmental Disorders*, 37, 1815-1821.
- Remington, B., Hastings, R. P., Kovshoff, H., degli Espinosa, F., Jahr, E., Brown, T., et al. (2007). Early intensive behavioral intervention: Outcomes for children with autism and their parents after two years. *American Journal on Mental Retardation*, 112, 418-438.
- Roberts, J. M. A., & Prior, M. (2006). A review of the research to identify the most effective models of practice in early intervention of children with autism spectrum disorders. Canberra: Department of Health and Ageing.
- Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation*, 110, 417-438+497.
- Scottish Intercollegiate Guidelines Network (2007). Assessment, diagnosis and clinical interventions for children and young people with autism spectrum disorders: a national clinical guideline. Edinburgh: Scottish Intercollegiate Guidelines Network.
- Sheinkopf, S. J., & Siegel, B. (1998). Home based behavioral treatment of young children with autism. *Journal of Autism and Developmental Disorders*, 28, 15-23.
- Smith, T. (1999). Outcome of early intervention for children with autism. *Clinical Psychology: Science and Practice*, 6, 33-49.
- Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal of Mental Retardation*, 105, 269-85.
- West, S., King, V., & Carey, T. S. (2002). *Systems to rate the strength of scientific evidence*: Research Triangle Institute-University of North Carolina Evidence-based Practice Center under Contract No. 290-97-0011. AHRQ Publication No. 02-E016. .
- Wetherby, A.-M., & Woods, J.-J. (2006). Early Social Interaction Project for Children with Autism Spectrum Disorders Beginning in the Second Year of Life: A Preliminary Study. *Topics in Early Childhood Special Education*, 26, 67-82.
- Yoder, P., & Stone, W.-L. (2006a). A Randomized Comparison of the Effect of Two Prelinguistic Communication Interventions on the Acquisition of Spoken

Communication in Preschoolers with ASD. *Journal of Speech, Language and Hearing Research*, 49, 698-711.

Yoder, P., & Stone, W. L. (2006b). Randomized comparison of two communication interventions for preschoolers with autism spectrum disorders. *Journal of Consulting and Clinical Psychology*, 74, 426-435.

Zachor, D. A., Ben-Itzhak, E., Rabinovich, A. L., & Lahat, E. (2007). Change in autism core symptoms with intervention. *Research in Autism Spectrum Disorders*, 1, 304-317.