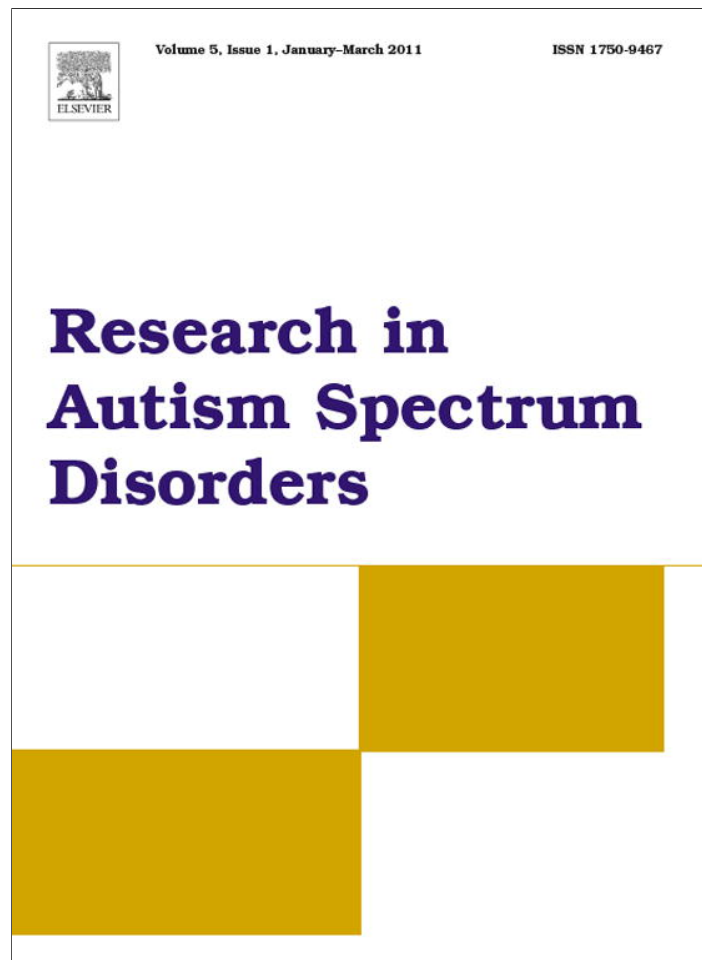


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Review

When all you have is a hammer . . . : RCTs and hegemony in science

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ABSTRACT

People diagnosed with autism spectrum disorder (ASD) deserve the same respect as any other person and should be free to benefit from scientific research that can help them achieve skills which enable them to reach their full potential. Over the past 40 years Applied Behaviour Analysis (ABA) has utilised inductive, natural science methods to investigate techniques for the analysis and augmentation of socially significant behaviours. Unfortunately, many individuals with ASD in the UK cannot avail of these techniques because of an obdurate reliance on randomised controlled trials (RCTs) as the single most respectable measure of effectiveness of interventions. In this paper we focus on how the debate about RCTs is played out in the 'autism wars'.

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If you want to examine the effectiveness of a particular drug on a population, the randomised controlled trial (RCT) is a simple yet powerful research tool. As a basic paradigm for a nomothetic or group-based approach to science, its power lies in the selection tactic of randomly assigning individuals to either the experimental group (the group that receives the targeted drug/s) or the control group (the group that receives another drug, often a placebo). Random assignment ensures that conclusions about the effectiveness of the target treatment on a population are not compromised by unexpected variables associated with selection bias; 'blinding/double blinding' of treatment and/or assessment adds rigor to the procedure (Fig. 1).

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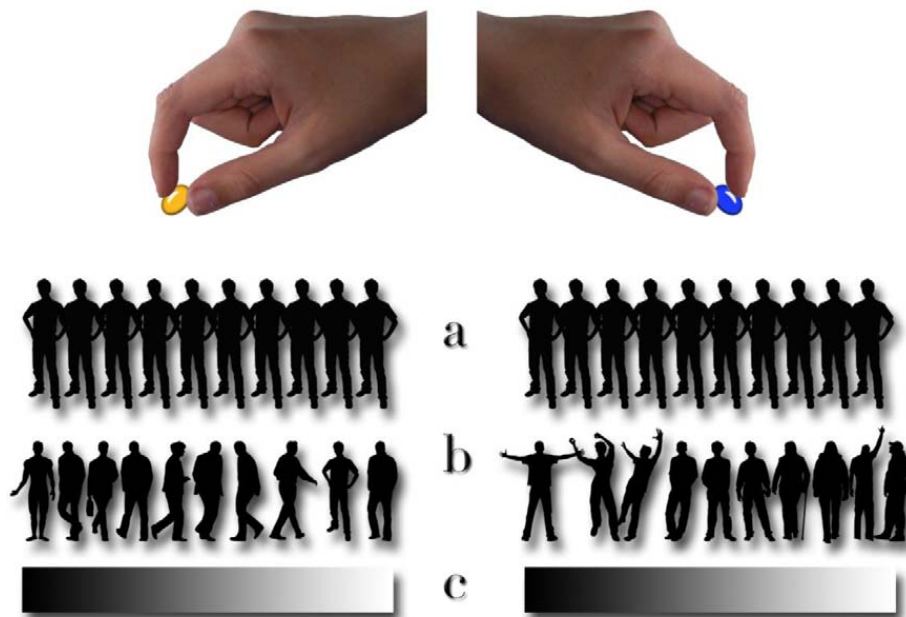


Fig. 1. (Panel a) In an idealised group design, a treatment drug (left-hand side) is given to a large number of participants in which variability between them is minimal. The control drug is given to a similar group of participants (right-hand side). (Panel b) Because an idealised group does not exist, participants for each group are randomly assigned to minimise the effects of extraneous variables that unexpectedly contribute to any differences between group results (RCT). (Panel c) Variability in individual responses that arise because of the effects of the drug, and/or variability in individual histories are represented by the spectrum.

Despite its simplicity, or perhaps because of it, the use of RCTs has stimulated much debate (Powers & Witmer, 1951; Smith & Pell, 2003). By-and-large, RCTs are held to provide the best clinical evidence available (NICE, 2009). The debate, however, hinges on the appropriateness of limiting research strategies to one experimental paradigm when assessing the efficacy/effectiveness² of different procedures in various settings (Edward, Carr, Granpesheh, & Grosman, 2009; Stephenson & Imrie, 1998). In this paper we outline this debate within the field of autism research. We focus on the behavioural treatment of autism and examine the ways in which a 'one model fits all mentality' of using RCTs to judge the appropriateness of an intervention has undermined the nature of scientific discourse which in turn has prevented many children diagnosed with an autism spectrum disorder (ASD) from receiving effective treatment.

It is not the aim of this paper to present a comprehensive discussion of the pros and cons of using Applied Behaviour Analysis (ABA). Rather, it is argued that much of the debate is mired in confusion whereby ABA is wrongly labelled as a specific form of autism treatment rather than being viewed correctly as an ideographic approach to science with its epistemology anchored in the natural science perspective of behaviour analysis (Chiesa, 1994; Hineline, 1990; Keenan, 1997; Keenan, Kerr, & Dillenburger, 2000; Keenan, Henderson, Kerr, & Dillenburger, 2005; Moore, 1985, 2008; Morris, 1985, 2009; PCDI, 2009; Schnaitter, 1987).

We begin with a brief description of ABA as it relates to the treatment of autism. Following this, we describe a populist view, i.e., that the jury is still out and that many empirical questions related to ABA are 'not yet scientifically settled' (Jordan, 2001, p. 421). This view is largely based in the argument that appropriate RCTs have not been conducted (BMJ, 2009; Ospina et al., 2008; Rogers & Vismara, 2008; Spreckley & Boyd, 2009) and that therefore ABA should not be wholeheartedly recommended as a basis for treatment and for governmental support (Maginnis, 2008; McConkey, Kelly, & Cassidy, 2007; Task Force Report, 2001; Task Group Report, 2002). Finally, we explain why exclusive reliance on inter-group designs, such as RCTs, is inappropriate for the design and evaluation of individualized treatment protocols.

1. Applied Behaviour Analysis (ABA)

The term Applied Behaviour Analysis was first defined by Baer, Wolf, and Risley (1968) and is understood as follows:

Applied Behavior Analysis is the science in which tactics derived from the principles of behavior are applied systematically to improve socially significant behavior and experimentation is used to identify the variables responsible for behavior change. (Cooper, Heron, & Heward, 2007, p. 20)

² 'Efficacy tends to differ from effectiveness because people who give informed consent to enter trials usually differ, in ways that affect outcome, from those who are eligible but decline or are not invited. Furthermore, taking part in research often involves procedures and commitments that are different from routine practice. In this sense, effectiveness cannot be judged from tightly controlled research, but without prior evidence of efficacy, it can be hard to attribute events in the real world to the effectiveness of an intervention.' (Stephenson and Imrie, 1998, p. 611).

The effectiveness of using ABA to design interventions for individuals diagnosed with ASD has been documented since the early 1960s (Wolf, Risley, & Mees, 1964). However, it was not until the 1980s, in an era when ASD was viewed as largely untreatable (DeMyer et al., 1974), that Lovaas (1987) documented substantial improvements in all, and near normal functioning in over 47%, of the 19 children who received comprehensive, intensive, long lasting, early behaviour analytic intervention. Gains in the intensive treatment group were maintained at follow-up, when the children averaged 13 years of age and had been out of treatment for 3–9 years (McEachin, Smith, & Lovaas, 1993).

Similar results were found in replication studies in the U.S.A. (Cohen, Amerine-Dickens, & Smith, 2006) and the UK (Remington et al., 2007). Generally, studies have been either centre-based (Eikeseth, Smith, Jahr, & Eldevik, 2002; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991), home-based (Birnbauer & Leach, 1993; Sheinkopf & Siegel, 1998; Smith, Groen, & Wynn, 2000; Weiss, 1999), or other (Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Stahmer & Ingersoll, 2004; Weiss, 1999) and indicate that cognitive functioning, language skills (Harris et al., 1991), and academic performance improved to or exceeded normal levels for many of the children who had received at least 2 years early intensive behaviour analytic treatment (Anderson et al., 1987; Green, 1996; Remington et al., 2007; Sallows & Graupner, 2005; Smith et al., 2000; Weiss, 1999). From a neurological perspective, we understand that early, particularly intensive, apposite stimulation is necessary for appropriate neurological development in children diagnosed with ASD (Niemann, 1996).

Foxx (2008) stated:

Applied behavior analysis (ABA) incorporates all of the factors identified by the US National Research Council as characteristic of effective interventions in educational and treatment programs for children who have autism. (p. 821)

In other words, ABA researchers and practitioners utilise the principles of behaviour discovered by behavioural scientists over the past 100 or so years to design effective, individually tailored treatment protocols to address socially relevant behaviours (cf., Matson, 2007; Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996; Myers & Johnson, 2007).

The effectiveness of ABA as a basis for the treatment of ASD has been recognised by, amongst others:

- U.S. Surgeon General (2000);
- The Supreme Court of British Columbia (2000);
- The California Department of Developmental Services (2002);
- The New York State Department of Health (1999);
- Maine Administrators of Services for Children with Disabilities (2000);
- Department of Defence (2007); as well as
- Maurice (1999), mother and one of the most famous authors on autism.

The *Autism Treatment Acceleration Act* (2009) currently in front of the U.S.A. government will, if passed, ensure U.S.A. wide funding for ABA-based interventions, as medically necessary evidence-based autism treatment. At the moment, 10 States in the U.S.A. (Arizona, Florida, Louisiana, Illinois, Indiana, Montana, New Mexico, Pennsylvania, South Carolina, and Texas) already have passed legislation that ABA is to be funded by medical insurance companies.

Some have criticised ABA for being expensive, however, repeated cost-benefit analysis have found that 'the cost savings substantially exceed the early intensive treatment cost for a candidate 3-year old child with autism or ASD. This conclusion holds for a wide range of cost assumptions and discount rates' (Columbia Pacific Consulting, 1999). Even the most extensive home-based programme costing an estimated £17,000 per annum covering a 50-week period is much cheaper than any (not ABA-based) special school placement that costs between £22,500 and £23,500 per annum covering a period of only 38-weeks (PEACH, 1997). In Ontario, Canada, estimated annual savings of over \$45 million (Motiwala, Gupta, Lilly, Ungar, & Coyte, 2006) lead to the policy to offer Intensive Behavioural Intervention (IBI) routinely to all individuals diagnosed with ASD. Apart from these considerable savings, of course, there would be no additional costs if staff already employed in special educational needs settings were fully trained in ABA.

Given the significant consensus about the effectiveness of ABA when used to design interventions for individuals diagnosed with ASD (The National Autism Center, 2009) and its cost effectiveness, it may come as a surprise to learn that there is a vocal counter position that dismisses this evidence, mainly because of the lack of RCTs in the research database. Much of the polemic is political in nature and at times involves extreme anti-ABA rhetoric (Dawson, 2004; Jordan, 2001; Morris, 2009). The consequences of this antagonism permeate so deeply that even when commendations of interventions are cited as '...excellent examples of what can be provided' (Baron-Cohen, 2007) there is no mention that these excellent examples are in fact derived from applications of ABA. Examples of unbalanced and erroneous views are found in a large number of highly influential Governmental reports that misrepresent ABA as, for example, a highly formalized treatment that is more or less the same as Lovaas therapy and/or behaviour modification (McConkey et al., 2007; Task Group Report, 2002; Task Force Report, 2001; The Autism Toolbox, 2009), that is mainly concerned with very young children and by implication not relevant to adolescents (Jones et al., 2007), that does not work with the learning styles of children diagnosed with ASD specifically and therefore does not consider ASD as important (Maginnis, 2008), and ultimately that many other forms of intervention use the same elements as ABA (Task Group Report, 2002). It is not the aim of this paper to review these reports fully, suffice it to note that most if not all have reservations about the research evidence on ABA and on this basis either dismiss ABA or recommend it as one of many treatment options, despite the fact that ABA-based interventions have

been shown to be more effective than eclectic treatments (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Zachor, Ben-Itzhak, Rabinovich, & Lahat, 2007).

Generally, there is nothing wrong with making mistakes as long as they are open to corrections. However, this has not been the case with these reports. They were authored and ratified without consultation with Board Certified Behaviour Analysts (BACB, 2009) and protestations from parents, professionals, and even letters from the European Association of Behaviour Analysis (EABA) have been either ignored or dismissed (Keenan, 2009a, 2009b; Mattaini, 2008; UNBIAS, 2009).

So why not just run some RCTs, maybe in the shape of so-called strategy trials, to conciliate the diversity of argument? Of course, RCT-type nomothetic studies have been conducted on a range of different approaches to social care, including certain types of manualised behavioural intervention strategies³ (BABCP, 2007) and on specific ABA-based intervention strategies for children diagnosed with ASD (Eikeseth et al., 2002; Reichow & Wolery, 2009; Smith et al., 2000, 2007; Sallows & Graupner, 2005). However, on closer inspection there are a number of limitations that go beyond problems with replicability and internal and/or external validity.

Ultimately, the focus of both the behavioural and medical sciences is the individual patient, and not the average patient, e.g., a 80% probability that a patient who presents with a certain symptomatology has a particular disease, leaves 20% of patients for whom the diagnosis would be incorrect. Since RCTs are based on group averages and statistical rather than clinical significance, results can be quite misleading. In other words, a statistically significant difference can be found between groups without clinically significant improvements in the treatment group. When variation in participant populations are factored in, the new treatment could be even less effective than indicated in the RCT results.

Another important point is that RCTs are 'considered ethical only when there is genuine uncertainty about which treatment to offer' (Stephenson & Imrie, 1998, p. 611). Forty years of research evidence in favour of ABA-based treatments mean that there is no genuine uncertainty about its effectiveness (cf. Larsson, 2005, who cites 33 pages of references in supporting evidence and Matson et al., 1996, who reviewed 500 studies; see also Matson, 2007; The National Autism Center, 2009). Therefore the ethics of random allocation to non-treatment group have been questioned (Morris, 2009).

With regard to treatment fidelity or integrity, RCTs are not appropriate tools for evaluating an inductive science like ABA. They are designed to evaluate certain clearly defined interventions (e.g., drugs in medical research) as long as the same intervention (NB. in strategy trials: series of interventions) can be applied to each participant in the experimental group and (reliably) not applied to the control group. Interventions based in ABA are not the same for each participant because they are individually tailored based on continuous data being collected during the intervention, i.e., interventions are adjusted in response to the effect they achieve on the target behaviour. Consequently, RCTs are not sensitive enough to evaluate the effectiveness of individually tailored interventions.

These arguments are not new (Green, 2008; Smith & Pell, 2003) but they continue to be ignored in the field of ASD interventions. The reason for this state of affairs is, as mentioned earlier, that RCTs have come to be accepted as THE gold standard for evidence-based practice research and are generally viewed as offering best available evidence (NICE, 2009). In the remainder of this paper we discuss the social and societal implications of this position and we elaborate on limitations of the RCT as a research tool in the analysis of behaviour.

2. Social impact of relying solely on RCTs

When evidence from RCTs is viewed as the gold standard by which policy decisions and practice recommendations are made and resources allocated,⁴ then it follows that lack of RCT-based evidence has negative impacts. In Northern Ireland the Department of Education actively promotes an eclectic approach to the treatment of ASD on the basis that there is 'no robust scientific evidence' to justify investing in ABA (Jordan, Jones, & Murray, 1998). Yet, when asked for research evidence that supports eclectic treatments they were unable to supply references, RCTs or otherwise. Service users are referred to the voluntary sector if they want to use ABA-based interventions due to lack of statutory provision (Keenan, 2007).

In Southern Ireland, parent initiatives were successful in setting up 12 'schools' that explicitly base their teaching on principles of ABA, however, the long-term government support for them is not guaranteed as indicated by a further 11 applications for ABA-based schools not being processed at the moment and numerous court/tribunal rulings against parents requesting ABA for their children. The extent of the struggle faced by parents was exemplified by the O'Cuanachain family case:

The parents of a young autistic boy who lost a €5m court battle to secure State funding for a dedicated form of education for their son will have to pay their own legal costs. Cian and Yvonne O'Cuanachain battled for 68 days in the High Court to oblige the State to provide Applied Behavioural Analysis (ABA) for their son, Sean. (Healy & McDonald, 2008)

³ Based on NICE clinical guidelines, a total of £173 million will be spent by 2010/11 in England alone on Improving Access to Psychological Treatments (IAPT, 2009).

⁴ A similar point has been made with respect to another much-used procedure, that of falling from the sky while attached to a parachute. Here Smith and Pell (2003) caricature the ethical difficulties of RCTs by concluding 'As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomised controlled trials. Advocates of evidence based medicine have criticised the adoption of interventions evaluated by using only observational data. We think that everyone might benefit if the most radical protagonists of evidence based medicine organised and participated in a double blind, randomised, placebo controlled, crossover trial of the parachute.' (Smith and Pell, 2003, p. 1459).

In the U.S.A. there are similar ongoing battles between parents and medical insurance companies that refuse to cover the cost of providing ABA treatment because they consider it as either non-medical, or unproven, or both (e.g., *Associated Press*, 2008). However, it seems that the tide may be turning in recent autism insurance reform legislation that ensures insurance payments for medically necessary behavioural treatment for autism (*Autism Speaks*, 2009; see also *Department of Defence*, 2007).

3. What exactly is ABA again?

We use this sub-heading to emphasis a point about the misunderstanding of ABA. Despite the available literature to clarify the matter (e.g., *Hagopian & Boelter*, 2009; *Keenan*, 2009a, 2009b; *Maurice, Green, & Luce*, 1996), in practice many professionals, academics, and politicians still think that ABA is a specific method or, as the Northern Irish Minister for Education stated publicly, just 'one of many commercially available interventions for children with autism' (*Ruane*, 2009). This is not surprising given that there are relatively few third level training courses worldwide (see *BACB*, 2009). While recently some Masters courses in Behaviour Analysis have been developed in Ireland and Wales, in England and Scotland there is currently no Masters level training and only one undergraduate course that includes accredited training in ABA (*University of Kent, Tizard Center*).

Lack of training, though, is not the only problem. The vociferous propagation of myths about ABA has been addressed elsewhere (*Cambridge Center for Behavioral Studies*, 2009; *Morris*, 2009; *Todd & Morris*, 1992). *Maurice* (1999), author of the popular book 'Let me hear your voice', captured the misrepresentations of ABA as follows:

There is widespread misunderstanding and distortion of the approach. Dozens of pseudo-scientific books and articles out there describe it as child abuse, a squelching of the spirit, a crushing of the soul. Treating the symptoms and not the "root cause," what ever that might be; a denial of the self, cruel, manipulative, dehumanizing, punishing, controlling; etc. etc. Moreover, even when people do not attack behavior analysis, they make glaringly ignorant statements about it, like "Oh yes, that's where they do discrete trials for forty hours a week." Or, "behavior management is for really low functioning kids. (p. 3)

To compound the problems, when these myths are challenged, behaviour analysts are viewed as trouble makers or their efforts are misconstrued as 'failure to engage with criticisms, inquisition and denunciation of any who criticise (however mildly), misrepresentation of critics, and proselytising exercises to gain converts and spread the word' (*Jordan*, 2001, p. 421).

Apart from getting it wrong about the origins and applications of ABA, the most common type of mistake is to consider ABA to be a discrete event, like a drug that can be applied distinctly (*Fig. 2*). This 'cookbook approach' (*Nickols*, 2003), where 'recipes' for interventions can be applied repeatedly and will always result in the same outcome, has lead to the science of ABA being wrongly included in the same category as specific procedures developed by behaviour analysts:

When ABA is mistakenly categorised as a therapy for autism, rather than as a science, it is listed alongside a range of techniques such as Discrete Trial Training (DTT), Picture Exchange Communication System (PECS), Verbal Behavior Analysis (VBA), Precision Teaching, generalisation and skill maintenance training, Pivotal Response Training (PRT), prompting and prompt fading, imitation and instruction, Aggression Replacement Training (ART), shaping, Intensive

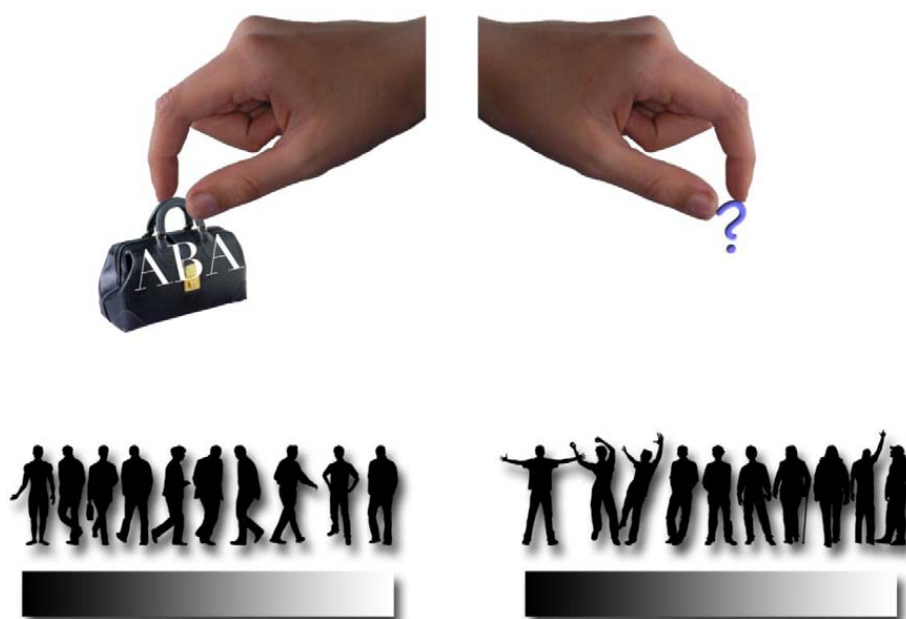


Fig. 2. An example of how ABA is mistakenly categorised as a discrete event, like a drug, that is given to people within a group design.

Behavioural Intervention (IBI), chaining, differential reinforcement, incidental teaching, extinction, and others (Green, 1996). However, it is the knowledge base gathered from the science of ABA that underpins all of these techniques. For practitioners, this means that learning specific techniques is not the same as learning the science. (Dillenburger & Keenan, 2009, p. 194)

The dangers of this kind of category mistake (Ryle, 1949) with respect to ABA have been discussed by Chiesa (2005):

Parents of newly diagnosed children, distressed and often desperate, are counseled to choose between a variety of 'therapies for autism', with ABA presented as though it were one among several possibilities. . . . When ABA is properly categorized, . . . the choice faced by parents and service providers changes to a choice between applied science and . . . something else. The new choice is like having a chest infection diagnosed by a doctor and hearing the doctor say 'you can choose to take these antibiotics, scientifically developed and rigorously tested, or you can take some of this white powder that my friend at the golf club says might be quite good'. In practice, where a reliable medication is available, doctors don't offer a choice between applied science and something else. And we, consumers, would not expect them to. . . . Yet this is what is happening in the professional realms of autism diagnosis and treatment as a result of the category error. (p. 236)

Chiesa goes on to note that a serious consequence of the category mistake is that it misleads parents and professionals into believing that training in ABA can be accomplished after a 1-day symposium, a 2-day workshop or a 3-week training course because these are the time scales on which training is often provided in commercial and/or manualised treatment packages (e.g., TEACCH; Mesibov, Shea, & Schopler, 2004).

The scientific approach of ABA is in keeping with all natural sciences where there is an emphasis on accountability and decisions are based on an understanding of how environmental contingencies affect public and private behaviours (Cooper et al., 2007; Moore, 2008). To dismiss ABA as only one method used to treat ASD, is like dismissing the findings of medicine because it too relies on one method only, i.e., an empirical scientific method. In keeping with the argument presented here, the recommendation would be that medical science should not be used without first conducting an RCT on medical science. This argument highlights the absurdity of demanding that RCTs be conducted to assess the utility of another science, i.e., Applied Behaviour Analysis (Chiesa, 2005)

4. If not RCTs, then what?

Knowing about behavioural techniques is not to be equated with being trained in the science of behaviour analysis any more than knowing how to manage constipation, or any other ailment, is to be equated with being trained in medicine. While fairly obvious, this point has serious implications for any study purporting to use ABA. We have already noted the limited approved training opportunities in this science and it would be surprising if this factor in itself did not impact negatively on treatment integrity across studies. Although this issue needs serious attention, there is an even more fundamental issue at the heart of this debate. It concerns the methods used to study the function of behaviour and behaviour changes. In the remainder of this paper we examine this point in more detail.

4.1. Behaviour

Johnston and Pennypacker (1993), in their seminal text, provide an excellent discussion on the differences between research methods examining the effects of independent variables on populations and those tailored specifically for the study of behaviour, i.e., within-subject designs. The distinction between these methodologies centres on basic issues regarding the definition of behaviour as used in the science of behaviour analysis.

Behavior results from an interactive condition between individual organisms and their environments. It is therefore a phenomenon that occurs only at the level of the individual. This means that it is only at this level that we can see the orderly relations that are the focus of our interest. Another important feature of behavior is that the organism–environment interactions that result in behavior occur through time. The methodological consequence of this fact is that we have to measure behavior over time in order to see the effects of these interactions clearly. (Johnston & Pennypacker, 1993)

Not only does this view on behaviour avoid dualism (Moore, 2008; Skinner, 1953), it emphasises the focus on controlling independent variables that affect behaviour rather than merely controlling which participant joins a treatment group and which participant joins a control group.

4.2. Within-subject designs

In RCTs statistical manipulations are carried out on group averages to see if significant correlations can be established between the group averages and independent variables. This probability-based approach is avoided when individual behavioural changes (dependent variables) are directly contingent upon changes in independent variables, regardless whether the latter changes are planned (controlled) or not. This kind of contingency analysis avoids a post hoc, ergo propter hoc (after this, therefore because of this) approach to science because causality is based in contingent not merely temporal or

statistical correlations. The key difference between these two research traditions lies in the way they approach the issue of experimental control.

The emphasis on obtaining a clear and complete picture of responding under each condition separately for each subject, which typifies within subject designs, encourages efforts to improve control by each condition, while minimizing control by extraneous variables. (Johnston & Pennypacker, 1993, p. 184)

The behaviour of each subject is measured repeatedly under the same condition and as such behavioural variability is considered a measure of the control attained in the conditions.

This approach to experimental control enhances the generality of the study's conclusions. In other words, improvements in the consistency and purity with which data reflect the effects of the conditions being compared improve the chances that the independent–dependent variable relations identified by the conclusions will be true and will hold up when examined or used under different circumstances. (Johnston & Pennypacker, 1993, p. 184)

With regard to external validity, Green (2008) outlines why results from within-system (or single-case) studies are much more readily generalisable to real life situations than large group studies:

1. many studies are conducted in everyday treatment settings, such as schools, homes, centers, and the like;
2. the studies address behaviors that are of interest to many practitioners, who are typically concerned with individual clients or consumers rather than statistical averages; and
3. the settings, participants, target behaviour, and baseline and treatment procedures are usually specified in the research report clearly enough that a reader can determine how closely they match the situation in which she is considering using the treatment. (p. 79)

Green (2008) concludes that, even more importantly, 'instead of addressing the generality of research findings indirectly via the logic of sampling from a population, behavior analysts investigate generality directly by replicating experiments with various participants, in various settings. Their goal is to learn enough about relations between independent and dependent variables through carefully controlled experiments to be able to reliably predict how an independent variable will affect the behavior of any individual' (p. 79).

There are of course a number of single-case studies that have had a major impact not only in intervention literature, for example, the study of patient "Tan" described by the French surgeon Paul Broca in 1861 which lay the foundations for what today is known as neuropsychology (Andrewes, 2001), or the use of case studies to build theories in organisational behavioural management (Eisenhardt, 1989).

In relation to autism treatment, the relevance of this scientific approach to understanding behaviour is captured by Anderson and Romanczyck (1999):

One of the important characteristics of children on the autistic spectrum is uneven learning ability and skill levels. Thus, individualization of intervention cannot be overstated. The specifics of programmes will be different for different children and must be sensitive to the child's needs. Thus, an important aspect of ABA is the introduction of procedures to quantify the child's behavior that can be used to create and evaluate individualized interventions. (p. 165)

Ultimately, the choice of research methodology should depend on the research question to be addressed. Actuarial questions related to who should pay for what may best be answered by group studies, however, research questions that pertain to the evaluation of the effectiveness of individually tailored treatments for children diagnosed with ASD, should be addressed by alternative methodologies, such as within-subject designs, that are particularly tailored to address these type of ideographic questions. Of course, data from these research methodologies ultimately should feed into actuarial decision making.

4.3. Shaping

In the context of a discussion of evidence basis for individualized interventions for ASD, a brief look at 'shaping' provides an insight into the divergence between two scientific traditions (Taub et al., 1994). A simple classroom practical using 'shaping' is used here to reveal the inadequacy of RCTs as research tools for understanding or measuring behaviour change contingent on environmental changes. Shaping⁵ is used in ABA-based interventions as one of the most powerful techniques for changing behaviour (Cooper et al., 2007; Prior, 2009). For obvious reasons, there has never been a RCT on shaping. Shaping can be viewed as the fluid application of ideographic science with a freely moving organism. Baseline data are taken, a known principle of behaviour is implemented (i.e., the use reinforcement), data are taken throughout this process and decisions on what to do next are based on data collected from the effects of the intervention. In other words, strategic

⁵ Shaping, or more correctly, shaping by successive approximations, lies at the foundation of many ABA-based treatment protocols used with individuals diagnosed with ASD.

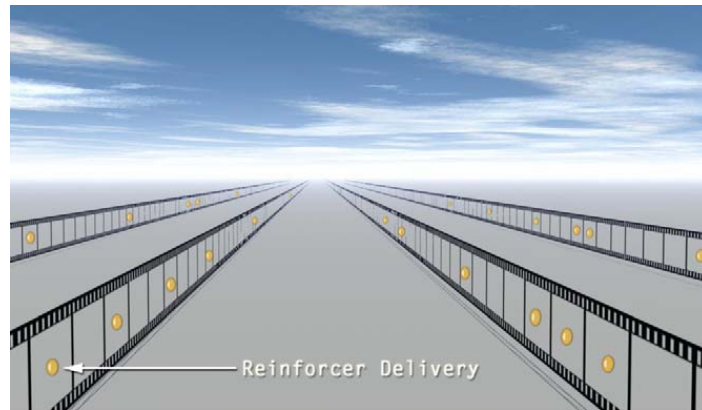


Fig. 3. When behaviour is shaped across time the scientific method guides the process insofar as strategic decision making is based on data collected. In this figure, the decision to deliver a reinforcer at each point in time for each individual is not prescriptive but is instead determined by the behaviour exhibited at that time. Real world applications are further complicated by the selection of different behaviours based on the problems presented and by the use of different reinforcers for each individual, often changing within a learning session.

decision making evolves in time with changes in the behaviour being shaped (Fig. 3). As a general approach for program delivery in autism Keenan (2005) noted that

within the sophisticated application of general principles of behaviour, fixed treatment recipes are avoided and instead data-based decision making steers the evolving programmes. Putting it another way, through data collection one is able to determine whether or not a particular programme is effective. If it is not effective, data on the progress of your child will tell you and the programme must be adjusted to enhance the learning opportunities for the child. Data collection will tell you also when the child has mastered the material in a particular programme, when you should move on to another programme, or how you should adjust your programme to facilitate generalization. (p. 32)

As a teaching tool for trainee behaviour analysts, the 'shaping game' (Keenan & Dillenburger, 2000), is widely used and includes the following:

1. Instructions are given to the participant, e.g., "Your goal is to get as many of these reinforcers as possible."
2. Reinforcers are delivered by the 'trainer' (i.e., the person doing the shaping) in the form of an audible sound from a clicker. The reinforcers are delivered as consequences for behaviours considered acceptable components leading up to a predetermined target behaviour (usually, the class is asked to define a target behaviour, while the 'experimental' student has left the room for a moment (cf. Prior, 2009).

Each 'shaping procedure' is individually tailored and therefore the details of what actually happens in a session are different for each participant (NB: shaping is the basis of most ABA-based interventions for children diagnosed with ASD). Because of this, it follows that it is impossible to replicate the same experiences for each participant in a treatment group. This fact is of central concern to the current discussion because unlike a drug, it means that participants are exposed to differing environmental events across time. To illustrate this point we outline a number of hypothetical RCTs designed to investigate shaping; let's assume randomisation has been addressed for both experimental and control groups:

1. Within RCTs we must ensure that individuals in the treatment group all get the exact same experience with respect to the independent variables (Instructions + Consequences) (Fig. 4). Managing instructions is easy; you just give the same instructions to each person at the start. Managing consequences is more problematic. How do we give everyone the same number and distribution of sounds? We could audio-record the distribution of the clicker sounds (i.e., agreed reinforcer) for one individual and replicate this distribution with all other individuals by playing the recorded sound to them. However, if this were done, and averaged results compared to a control group who got no clicker sounds, you would find that there is no difference between experimental and control groups because both groups would have failed to produce the target behaviour. In fact, only one individual would have produced the target behaviour, the first one trained. The logical conclusion would be that 'Shaping' does not work!
2. The experiment above is flawed because it is not the clicker sound per se that is crucial, but the contingency between the behaviour and the delivery of the consequence. We might decide to 'give everyone in the experimental group the same contingency' and compare the results with the control group who 'don't get the contingency'. Our problem here is defining what it means to 'get the contingency'. In practice, consequences are delivered for different behaviours across different individuals and at different rates across different time spans. It is impossible to standardise delivery of the independent variable, 'a contingency'. Delivering what ultimately constitutes a different intervention to participants in the experimental group would invalidate the RCT; if, for example, in a medical RCT the active ingredients of a particular drug were delivered in various concentrations, and at different rates across different time spans the RCT would be considered seriously flawed.

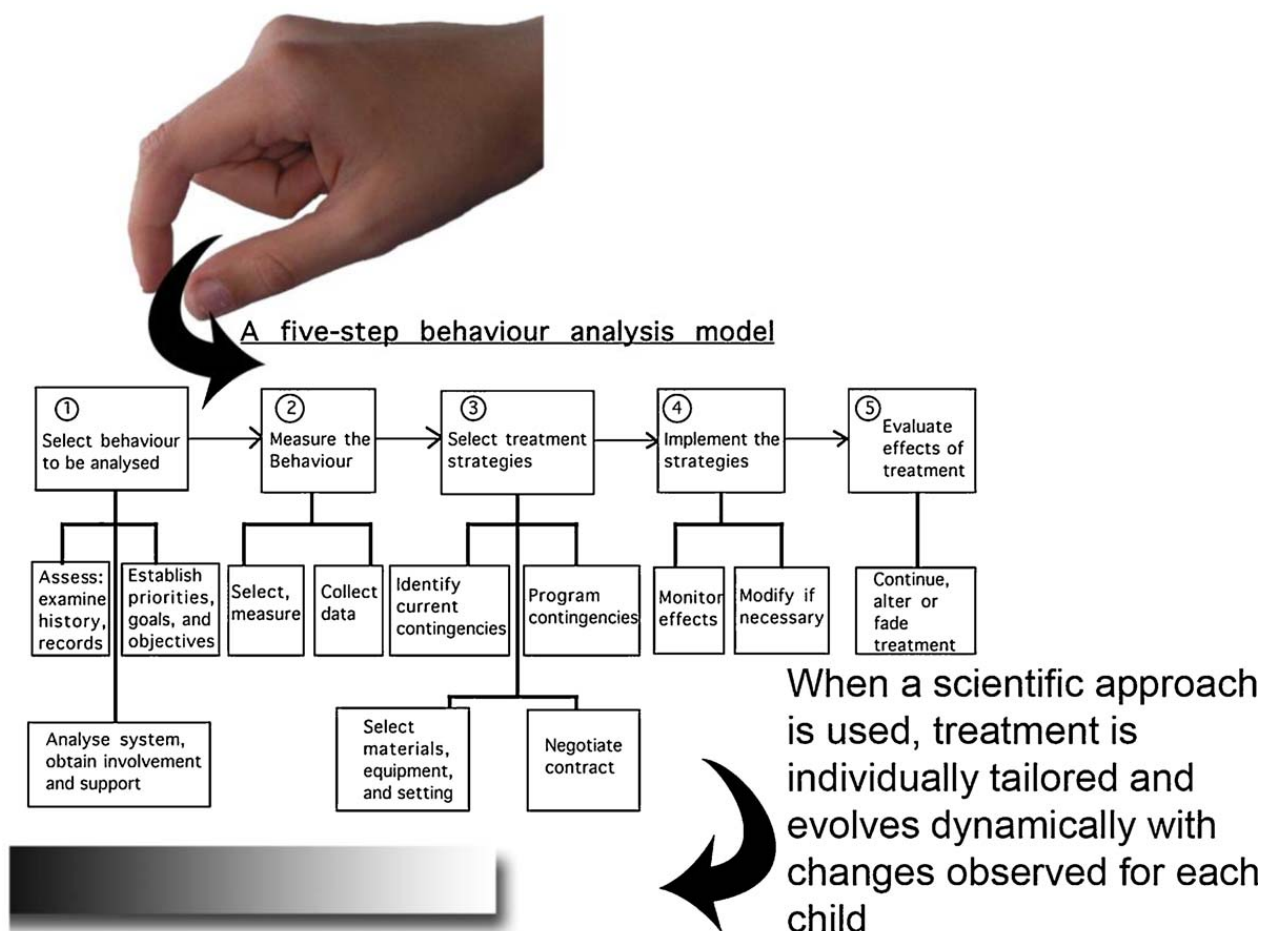


Fig. 4. The scientific method used in ABA provides a clear alternative to scientific method associated with RCTs when it comes to developing tailor-made procedures for producing and monitoring changes in an individual (adapted from Reese, 1978).

3. It might be assumed that the simplest thing to do would be NOT to dismember the components of shaping and compare two groups, one that 'gets shaping' and one that does not. Unfortunately this solution raises more problems. Firstly, given that we already know that shaping is effective we would be guilty of ignoring the principle of equipoise (Freedman, 1987), which provides the ethical basis for medical research involving randomly assigning patients to different treatments. Secondly, there is an issue concerning the nature of the target behaviour and this is where the link into real world issues with autism is crucial. In a classroom demonstration one would picture the same target behaviour for all participants, and all would achieve it (so why the need for a RCT in the first place?). In the case of a child with autism target behaviours are defined by the skill deficits or excesses specific to each child. With well-defined target behaviours, the rationale of shaping is to see how far along the path each child can come. There may be limits to change, but you will not know this until you begin shaping. And along the way there will be adjustments made, perhaps because other unforeseen skill deficits/excesses surface (McDowell & Keenan, 2001). By the end of a specified time period each child will have made progress, but to different degrees. But here's the problem. As is the case in all group designs, a RCT would average the data for each child, and the conclusion drawn about the 'treatment' would be based on different starting points for each child, different rates of progress for each of them, different intensities of exposure to the independent variable, and different end points for each child; all in all a right hotchpotch instead of a standardised procedure.

Bearing in mind that the intention behind conducting scientific research in the first instance is to tell us something about the effects of a putative independent variable, the results of all these hypothetical studies on shaping would typify many of the criticism often made about group designs in relation to their usefulness for studying behaviour:

Instead of controlling its sources before the fact, the between groups approach instead emphasizes controlling variability statistically after the fact. These two tactics do not have the same effects on the database, however. Whereas efforts to control actual variability lead to improved control over responding and, thus, a clearer picture of the effects of each condition, statistical manipulation of variable data cannot remove the influences already represented in the data. What is manipulated is how we talk about the data, a tactic that is less likely to enhance generality. (Johnston & Pennypacker, 1993).

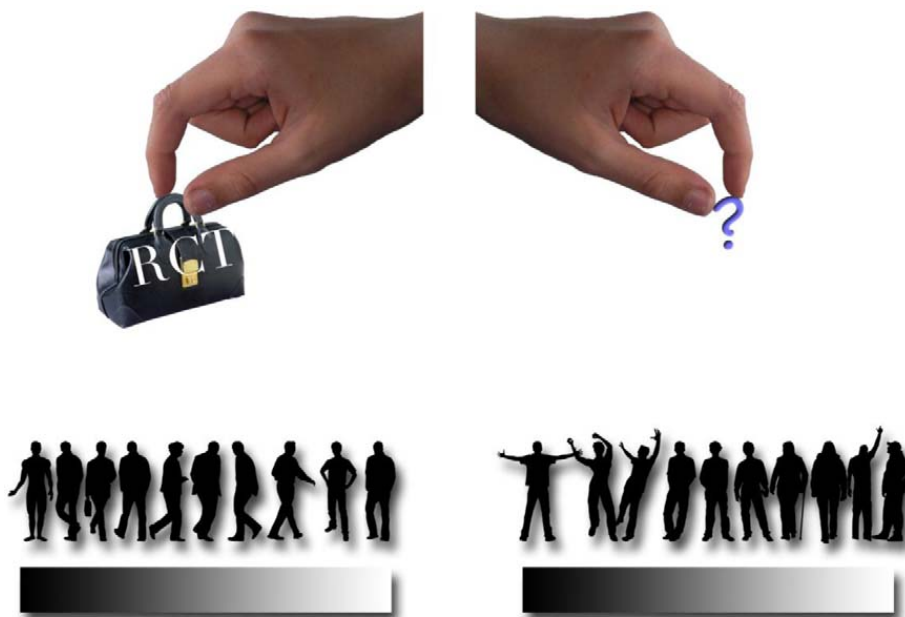


Fig. 5. The same category mistake normally made with ABA is used here with RCTs to illustrate the absurdity of asking for RCTs of ABA.

There are some major lessons from this discussion on shaping. First, it could be argued that professionals are behaving unethically if they use it in spite of the lack of evidence of its effectiveness from RCTs. Equally, one could ask how such a powerful procedure slipped through the net of acceptable procedures (as defined by the proponents of RCTs). Bearing in mind that shaping encompasses the scientific method (i.e., data-based decision making) as applied to an individual in the examples above, a somewhat absurd position is expressed by the following question: do we need to use a RCT to determine whether we should be using the scientific method to guide decision making? Clearly, this does not make sense. To complicate matters in real world applications, shaping will be embedded as only one component in the overall range of procedures that evolve contemporaneously with changes in behaviour within an individually tailored behavioural program for children with autism (Fig. 5). In other words, the category mistake of viewing ABA as one specific treatment for autism (amongst many) rather than a meticulous scientific approach is completely misleading for those who turn to the scientific method to guide decision making for behavioural programs. Fig. 5 shows the irrationality of this position if a similar category mistake were to be made with regards to RCTs (i.e., a specific scientific method). If we have to run RCTs for the scientific methods of ABA, logically, we should also run RCTs on the scientific method of using RCTs.

5. Conclusion

The debate regarding the use of ABA for the treatment of ASD centres on the following argument:

Before we can confidently employ a procedure like ABA to meet the needs of an individual, there needs to be a scientific study based on group designs (RCT) to assess whether it is appropriate to use that treatment with an individual.

However, when that seemingly sensible statement is translated with a proper understanding of ABA it reads as follows:

Before we can confidently employ the scientific method to meet the needs of an individual using known principles of behaviour, there needs to be a scientific study based on group designs (RCT) to assess whether it is appropriate to use the scientific method employed in single case designs with an individual.

There are two conflated issues here. First, the medical model is being used inappropriately to reify a complex set of procedures into a thing, like a drug. Second, group designs by their very nature are designed to provide information on populations, not individuals, and therefore they provide little guidance on how to tailor treatment for a given individual.

We have shown here how serious social consequences arise from a mixture of misinformation about the science of ABA and a 'one size fits all' mentality regarding the nature of the scientific method (Morris, 2009). That being so, the actions of governments and professional bodies who refuse to engage with professionals trained in ABA can be regarded as ethically irresponsible (Keenan, 2009a; Mattaini, 2008). Clearly, methods based on science should be utilised when educating children with autism. Each child is different and the scientific methods used in Applied Behaviour Analysis allow us to maximise each child's potential by assessing the effectiveness of how we teach and what we teach. 'The profession of behavior analysis has made scientific evidence the primary source of clinical decision making from its inception' (Green, 2008, p. 69).

Resource allocation for services and funding for research is usually predicated on the implementation of a RCT group design. As a consequence, behaviour analytic researchers are faced with hegemony over definitions of the scientific method. Scientific debate is thereby channelled into a stagnant millpond of claim and counter claim and somehow RCTs seem to dominate accepted wisdom. Is it because their guardians are better researchers, or because they hold the purse strings, or is it because they have not been trained in the science of behaviour?

References

- Anderson, S. R., Avery, D. L., DiPietro, E. K., Edwards, G. L., & Christian, W. P. (1987). Intensive home-based early intervention with autistic children. *Education and Treatment of Children*, 10, 352–366.
- Anderson, S. R., & Romanczyk, R. G. (1999). Early intervention for young children with autism: Continuum-based behavioural models. *Journal of the Association for Persons with Severe Handicaps*, 24, 162–173.
- Andrewes, D. G. (2001). *Neuropsychology: From theory to practice*. Portland, OR: Book News Inc.
- Associated Press. (2008). *Parents press states for autism insurance laws*. MSNBC (October 20). Retrieved from the Web 06/02/2009. <http://www.msnbc.msn.com/id/27276558/>.
- Autism Treatment Acceleration Act. (2009). Retrieved from the Web 10/19/2009. <http://www.govtrack.us/congress/bill.xpd?bill=s111-819>.
- Autism Speaks. (2009). *Autism votes*. Retrieved from the Web 06/02/2009. http://www.autismvotes.org/site/c.frKN13PCImE/b.4172687/k.2867/New_Jersey.htm.
- Baer, D., Wolf, M., & Risley, R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis*, 1, 91–97.
- Baron-Cohen, S. (2007). Freedom of expression. *The Times* (December 15). Retrieved from the Web 06/01/2009. http://www.women.timesonline.co.uk/tol/life_and_style/women/body_and_soul/article3051335.ece.
- Behaviour Analysis Certification Board. (BACB, 2009). *Accredited course sequences*. Retrieved from the Web 06/21/2009. www.bacb.com.
- Birnbrauer, J. S., & Leach, D. J. (1993). The Murdock early intervention program after 2 years. *Behaviour Change*, 10, 63–74.
- British Association for Counselling and Psychotherapy. (BABCP, 2007). *Evidence submitted by the BABCP (NICE 92)*. Retrieved from the Web 14/10/2009. <http://www.publications.parliament.uk/pa/cm200607/cmselect/cmhealth/503/503we18.htm>.
- British Medical Journal* (BMJ, 2009) Best Practice. Applied Behavioural Analysis. Retrieved from the Web 19/05/2009. <http://bestpractice.bmj.com/bestpractice/monograph/379/treatment/evidence/intervention/0322/0/sr-0322-i2.html>.
- Cambridge Center for Behavioral Studies. (2009). Retrieved from the Web 19/05/2009. <http://www.behavior.org>.
- Chiesa, M. (1994). *Radical behaviorism: The philosophy and the science*. Boston: Authors Cooperative Inc Publishers.
- Chiesa, M. (2005). ABA is not 'A Therapy for Autism'. In M. Keenan, M. Henderson, K. P. Kerr, & K. Dillenburger (Eds.), *Applied behaviour analysis and autism: Building a future together* (pp. 225–240). London: Jessica Kingsley Publishers.
- Cohen, H., Amerine-Dickens, M., & Smith, T. (2006). Early intensive behavioral treatment: Replication of the UCLA model in a community setting. *Journal of Developmental & Behavioral Pediatrics*, 27, S145–S155.
- Columbia Pacific Consulting. (1999). *Cost-benefit analysis. Prepared for Harper Grey Easton, Barrister and Solicitors*. CPC 1550-650 West Georgia Street, Vancouver, B.C. V6B 4N8.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.
- Dawson, M. (2004). *The misbehaviour of behaviourists. Ethical challenges to the Autism-ABA Industry*. Retrieved from the Web 06/01/2009. http://www.sentex.net/~nexus23/naa_02.html.
- DeMyer, M. K., Barton, S., Alpern, G. D., Kimberlin, C., Allen, J., & Steele, R. (1974). The measured intelligence of autistic children. *Journal of Autism and Childhood Schizophrenia*, 4, 42–60.
- Department of Defence. (2007, July). *Report and plan on services to military dependent children with autism*. USA: Department of Defence.
- Dillenburger, K., & Keenan, M. (2009). None of the As in ABA stands for autism: Dispelling the myths. *Journal of Intellectual & Developmental Disability*, 34, 193–195.
- Edward G., Carr, E. G., Granpesheh, D., & Grosman, L. (2009). *The future of applied behavior analysis in autism spectrum disorder: New opportunities for improving lives*. Retrieved from the Web 05/19/2009. <http://www.education.com/reference/article/applied-behavior-analysis-autism-ABA-future/>.
- Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2002). Intensive behavioral treatment at school for 4- to 7-year old children with autism. *Behavior Modification*, 26, 49–68.
- Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, 14, 532–550.
- Foxx, R. M. (2008). Applied behavior analysis treatment of autism: The state of the art. *Child and Adolescent Psychiatric Clinics of North America*, 17, 821–834.
- Freedman, B. (1987). Equipose and the ethics of clinical research. *New England Journal of Medicine*, 317, 141–145.
- Green, G. (1996). Early behavioral intervention for autism: What does research tell us? In C. Maurice, G. Green, & S. Luce (Eds.), *Behavioral intervention for young children with autism: A manual for parents and professionals* (pp. 29–44). Austin, TX: PRO-ED.
- Green, G. (2008). Single-case research methods for evaluating treatments for autism spectrum disorders. *Opportunities... Hope... Potential... The future of Pennsylvania, Autism in Pennsylvania: What lies ahead*, 8, 69–81.
- Hagopian, L. P., & Boelter, E. W. (2009). *Applied Behavioral Analysis: Overview and summary of scientific support*. The Woodlands, TX: FEAT-Houston, Newsletter (Special Edition II).
- Harris, S. L., Handleman, J. S., Gordon, R., Kristoff, B., & Fuentes, F. (1991). Changes in cognitive and language functioning of preschool children with autism. *Journal of Autism and Developmental Disorders*, 21, 281–290.
- Healy, T., & McDonald, D. (2008). *Agony for autism case parents. Couple face losing home to pay €5m court battle costs*. *Independent* (January, 30). Retrieved from the Web 06/02/2009. www.independent.ie/national-news/agonny-for-autism-case-parents-1277097.html.
- Hineline, P. N. (1990). The origins of environment-based psychological theory. *Journal of The Experimental Analysis of Behavior*, 53, 305–320.
- 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.
- Improved Access to Psychological Therapies. (IAPT, 2009). Retrieved from the Web, 06/21/2009. <http://www.iapt.nhs.uk/>.
- Johnston, J. M., & Pennypacker, H. S. (1993). *Within subject versus between groups designs: Comparing experimental outcomes. Readings for strategies and tactics of behavioral research* (second ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
- Jones, G., Ellins, J., Guldborg, K., Jordan, R., MacLeod, A., & Plimley, L. (2007). *A review of the needs and services for 10–18 year-old children and young people diagnosed with Asperger Syndrome living in Northern Ireland*. Belfast: The Northern Ireland Commissioner for Children and Young People (NICCY).
- Jordan, R. (2001). Book review. *Journal of Child Psychology and Psychiatry*, 42, 421.
- Jordan, R., Jones, G., & Murray, D. (1998). *Educational Interventions for Children with Autism: A Literature Review of Recent and Current Research*. Sudbury: Department for Education and Employment.
- Keenan, K. (2007). *Draft: A strategy for Autism Spectrum Disorder in the Northern Health and Social Services Board*. Ballymena, NI: Social Services Directorate.
- Keenan, M. (1997). 'W'-ing: Teaching exercises for radical behaviourists. In K. Dillenburger, M. O'Reilly, & M. Keenan (Eds.), *Advances in Behaviour Analysis* (pp. 48–80). Dublin: University College Dublin Press.
- Keenan, M. (2005). Empowering parents with science. In M. Keenan, M. Henderson, K. P. Kerr, & K. Dillenburger (Eds.), *Applied behaviour analysis and autism. Building a future together* (pp. 18–52). London: Jessica Kingsley Publishers.
- Keenan, M. (2009a). Letters to the editor. *The Psychologist*, 22, 6–7.
- Keenan, M. (2009b). Letters to the editor. *The Psychologist*, 22, 90–91.
- Keenan, M., & Dillenburger, K. (2000). Images of behavior analysis: The shaping game and the behavioral stream. *Behavior and Social Issues*, 10, 19–38.

- Keenan, M., Henderson, M., Kerr, K. P., & Dillenburger, K. (Eds.). (2005). *Applied behaviour analysis and autism: Building a future together*. London: Jessica Kingsley Publishers.
- Keenan, M., Kerr, K. J., & Dillenburger, K. (Eds.). (2000). *Parents' education as autism therapists. Applied behaviour analysis in context*. London: Jessica Kingsley Publishers.
- Larsson, E. (2005). Resources for parents. In M. Keenan, M. Henderson, K. P. Kerr, & K. Dillenburger (Eds.), *Applied behaviour analysis and autism. Building a future together* (pp. 255–287). London: Jessica Kingsley Publishers.
- 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.
- Maginnis, K. (2008). *Independent review of autism services*. Belfast: Department of Health.
- Maine Administrators of Services for Children with Disabilities. (MADSEC, 2000) *Report of the MADSEC Autism Task Force*. Retrieved from the Web 05/07/2009. www.madsec.org/docs/ATFReport.pdf.
- Matson, J. L. (2007). Current status of differential diagnosis for children with autism spectrum disorders. *Research in Developmental Disabilities*, *28*, 109–118.
- Matson, J. L., Benavidez, D. A., Compton, L. S., Paclawskyj, T., & Baglio, C. (1996). Behavioral treatment of autistic persons: A review of research from 1980 to the present. *Research in Developmental Disabilities*, *17*, 433–465.
- Mattaini, M. (2008). *Leading experts concerned about Maginnis Review of Autism Services*. Retrieved from the Web 06/10/2009. www.peatni.org/news/article.asp?ArticleID=aba_autism_independent_review_peat.
- Maurice, C. (1999). *Address to the Cambridge Center for Behavioral Studies (CCBS). Annual Board Meeting, Palm Beach, Florida (November 5)*.
- Maurice, C., Green, G., & Luce, S. (Eds.). (1996). *Behavioral intervention for young children with autism: A manual for parents and professionals*. Austin, TX: PRO-ED.
- McDowell, C., & Keenan, M. (2001). Cumulative dysfluency. Still evident in our classroom despite what we know. *Journal of Precision Teaching and Celebration*, *XVII*, 1–6.
- McConkey, R., Kelly, G., & Cassidy, A. (2007). *An evaluation of the need and early Intervention support for children (aged 2–4 years) with an Autistic Spectrum Disorder in Northern Ireland*. Belfast: Department of Education.
- McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation*, *97*, 359–372.
- Mesibov, G. B., Shea, V., & Schopler, E. (2004). *The TEACCH approach to Autism Spectrum Disorders (Kindle Edition)*. Springer.
- Moore, J. (1985). Some historical and conceptual relations among logical positivism, operationism, and behaviorism. *The Behavior Analyst*, *8*, 53–63.
- Moore, J. (2008). *Conceptual foundations of radical behaviorism*. Cornwall-on-Hudson, NY: Sloan Publishing.
- Morris, E. K. (1985). Public information, dissemination, and behavior analysis. *The Behavior Analyst*, *8*, 95–110.
- Morris, E. K. (2009). A case study in the misrepresentation of applied behavior analysis in autism: The Gernsbacher lectures. *The Behavior Analyst*, *32*, 205–240.
- Motiwala, S. S., Gupta, S., Lilly, M. B., Ungar, W. J., & Coyte, P. C. (2006). The cost-effectiveness of expanding Intensive Behavioural Intervention to all autistic children in Ontario. *Health Policy*, *1*, 135–151.
- Myers, S. M., & Johnson, C. P. (2007). Management of children with Autism Spectrum Disorders. *Pediatrics*, *120*, 1162–1182.
- National Institute of Clinical Excellence. (NICE, 2009). *Published Clinical Guidelines*. Retrieved from the Web 06/21/2009. <http://www.nice.org.uk/Guidance/CG/Published>.
- Nickols, F. (2003) *Evaluating Training. There is no "cookbook" approach*. Distance Consulting retrieved from the Web 05/07/2009. <http://www.nickols.us>.
- Niemann, G. W. (1996). *The neurodevelopment of autism. Recent advances*. Advances in the Assessment and Management of Autism. Association for Child Psychology and Psychiatry Occasional Papers. No. 13.
- Ospina, M. B., Krebs Seida, J., Clark, B., Karkhaneh, M., Hartling, L., Tjosvold, L., et al. (2008). Behavioural and developmental interventions for autism spectrum disorder: A clinical systematic review. *PLoS ONE*, *3*, e3755.
- Princeton Child Development Institute. (PCDI, 2009). Retrieved from Web 05/07/2009. <http://www.pcdi.org/>.
- Parents for the Early Intervention in Autism in Children. (PEACH, 1997). Retrieved from the Web 11/20/2007. <http://www.peach.org.uk>.
- Powers, E., & Witmer, H. (1951). *An experiment in the prevention of delinquency – The Cambridge-Somerville Youth Study*. New York: Columbia University Press.
- Prior, K. (2009). *Clicker training*. Retrieved from the Web 06/23/2009. <http://www.clickertraining.com/>.
- Reese, E. (1978). *Human operant behavior: Analysis and application*. Brown & Benchmark.
- Reichow, B., & Wolery, M. (2009). Comprehensive synthesis of early intensive behavioral interventions for young children with autism based on the UCLA Young Autism Project model. *Journal of Autism and Developmental Disorders*, *39*, 23–41.
- Remington, B., Hastings, R., Kovshoff, H., degli Espinosa, F., Jahr, E., Brown, T., et al. (2007). A field effectiveness study of early intensive behavioral intervention: Outcomes for children with autism and their parents after two years. *American Journal on Mental Retardation*, *112*, 418–438.
- Rogers, S. J., & Vismara, L. A. (2008). Evidence-based comprehensive treatments for early autism. *Journal of Clinical Child and Adolescent Psychology*, *37*, 8–38.
- Ruane, C. (2009). *Answer to Ministerial Question from George Robinson MLA*. Bangor, NI: Letter dated June 17, 2009.
- Ryle, G. (1949). *The concept of mind*. Chicago, IL: The University of Chicago Press.
- Sallows, G., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation*, *110*, 417–438.
- Schnaitter, R. (1987). Knowledge as action: The epistemology of radical behaviorism. In S. Modgil & C. Modgil (Eds.), *B. F. Skinner: Consensus and controversy*. New York: Falmer Press.
- Sheinkopf, S. J., & Siegel, B. (1998). Home-based behavioral treatment of young children with autism. *Journal of Autism and Developmental Disorders*, *23*, 15–23.
- Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.
- Smith, G. C. S., & Pell, J. P. (2003). Hazardous journey. Parachute use to prevent death and major trauma related to gravitational challenge: Systematic review of randomised controlled trials. *British Medical Journal*, *327*, 1459–1461.
- 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*, 269–285.
- Smith, T., Scahill, L., Dawson, G., Guthrie, D., Lord, C., Odom, S., et al. (2007). Designing research studies on psychosocial interventions in autism. *Journal of Autism and Developmental Disorders*, *37*, 354–366.
- Spreckley, M., & Boyd, R. (2009). Efficacy of applied behavioral intervention in preschool children with autism for improving cognitive, language, and adaptive behavior: A systematic review and meta-analysis. *The Journal of Pediatrics*, *154*, 338–344.
- Stahmer, A., & Ingersoll, B. (2004). Inclusive programming for toddlers with autism spectrum disorders: Outcomes from the children's toddler school. *Journal of Positive Behavior Interventions*, *6*, 67–82.
- Stephenson, J., & Imrie, J. (1998). Why do we need randomised controlled trials to assess behavioural interventions? *British Medical Journal*, *14*, 611–613.
- Task Force Report. (2001). *Educational provision and support for persons with autistic spectrum disorders*. Dublin: Department Education and Science.
- Task Group Report. (2002). *The education of children and young people with autistic spectrum disorders*. Belfast: Department of Education.
- Taub, E., Crago, J. E., Burgio, L. D., Groomes, T. E., Cook, E. W., DeLuca, S. C., et al. (1994). An operant approach to rehabilitation medicine: Overcoming learned nonuse by shaping. *Journal of Experimental Analysis of Behavior*, *61*, 281–293.
- The Autism Toolbox. (2009). Retrieved from the Web 05/07/2009. <http://www.scotland.gov.uk/Publications/2009/03/30104653/0>.
- The California State Department of Developmental Services. (2002). *Autistic Spectrum Disorders: Best Practice Guidelines for Screening, Diagnosis and Assessment*. Retrieved from the Web 05/07/2009. <http://www.dds.ca.gov/Autism/Home.cfm>.
- The National Autism Center. (2009). *The national standards project: Addressing the need for evidence-based practice guidelines for autism spectrum disorders*. Randolph, MA: The National Autism Center.
- The New York State Department of Health. (1999). *Guidelines: Autism/Pervasive Development Disorders, Assessment and Intervention for Young Children (0–3), Chapter IV – Behavioral and Educational Approaches*. Retrieved from the Web 05/07/2009. http://www.health.state.ny.us/community/infants_children/early_intervention/disorders/autism/.

- The Supreme Court of British Columbia. (2000). *Anderson et al. v. Attorney General of British Columbia*. Retrieved from the Web 05/07/2009. <http://featbc.org/downloads/AndersonJudgement.pdf>.
- Todd, J. T., & Morris, E. K. (1992). Case histories in the great power of steady misinterpretation. *American Psychologist*, 47, 1441–1453.
- UNBIAS 2009. (2009). *Mission statement*. Retrieved from the Web 14/10/2009. <http://sites.google.com/site/unbias2009/>.
- U.S. Surgeon General. (2000). *Surgeon General's Report on Mental Health – subsection on Autism*. Retrieved from the Web 05/07/2009. <http://www.surgeongeneral.gov/>.
- Weiss, M. J. (1999). Differential rates of skill acquisition and outcomes of early intensive behavioral intervention for autism. *Behavioral Interventions*, 14, 3–22.
- Wolf, M. M., Risley, T., & Mees, H. L. (1964). Application of operant conditioning procedures to the behavior problems of an autistic child. *Behaviour Research and Therapy*, 1, 305–312.
- Zachor, D. A., Ben-Itzhak, E., Rabinovich, A., & Lahat, E. (2007). Change in autism core symptoms with intervention. *Research in Autism Spectrum Disorders*, 1, 304–317.