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BEHAVIOUR ANALYSIS

Cost-effective models for delivering behaviour analysis teaching in UK schools and local authorities

Susan McCandless and *Marguerite Hoerger*

Education programmes based on behaviour analysis are often used to teach children with learning disabilities. A common application of behaviour analysis is Early Intensive Behaviour Intervention (EIBI), which is evidence-based, but most children in the UK do not have access to this approach. EIBI is usually implemented for 30 to 40 hours per week, over two years. High levels of supervision from behaviour analysts are essential to ensure EIBI's effectiveness. A recent cost-effectiveness study concluded that EIBI was not cost-effective: while the children make progress relative to treatment as usual, the outcomes did not justify the cost of the intervention. Other low-cost models of delivery need to be considered. School-based models used in the UK may provide cost-effective and sustainable ways to use applied behaviour analysis in schools. They could be used in other local authorities to increase access to an education that includes behaviour analysis.

Key words: **applied behaviour analysis, autism, cost-effectiveness, intellectual disability**

Education programmes based on behaviour analysis are commonly used for children with learning disabilities. Behaviour analysis programmes are considered best practice in countries such as the USA (McPhilmey & Dillenburger, 2013), Canada (Shepherd & Waddell, 2015) and Norway (Eldevik et al., 2019). However, schools and local authorities in the UK have struggled to

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incorporate behaviour analysis into their provision and consequently few children have access to the approach. The National Institute for Health and Care Excellence (NICE) provides guidelines on the evidence for interventions and recommends those that are cost-effective. A recent systematic review and cost-effectiveness analysis (Rodgers et al., 2020) found that those receiving Early Intensive Behaviour Intervention (EIBI) made greater gains on measures of IQ and adaptive behaviour than those receiving treatment as usual (TAU) or eclectic treatment. However, EIBI could not be considered cost-effective by NICE thresholds due to the increased cost that is associated with EIBI compared to TAU.

While the recommendations by Rogers et al. (2020) are specifically relevant to medical interventions, we feel they may discourage schools and local authorities from exploring how behaviour analysis can be used in educational settings in a multi-disciplinary context. An education that includes behaviour analysis does not need to be 'all or none' – models that integrate behaviour analysis into maintained school provision have led to positive outcomes.

This article sets out alternative delivery models that can be used in schools to effectively teach young children with intellectual disabilities. EIBI is only one model that provides an education based in behaviour analysis. Other, more affordable models need to be explored so that children with special educational needs and disabilities may benefit from learning based on a behavioural approach. This article outlines the home-based model, which is commonly used in the UK, and three models that are used within maintained and academy schools. The school-based models are less expensive to implement than the model considered by Rodgers et al. (2020) and may provide a cost-effective way for a behavioural education to be delivered in the UK.

What is EIBI?

EIBI uses the principles of behaviour analysis in programmes to increase skills and decrease challenging behaviour in young children with intellectual disability. The programmes tend to begin before the child is six years old and are conducted for 30 to 40 hours per week (Peters-Scheffer et al., 2013). There is a significant evidence base demonstrating that children who participate in EIBI show greater improvements on measures of IQ, adaptive behaviour and language skills relative to control groups (Eldevik et al., 2009; Peters-Scheffer et al., 2011; Virues-Ortéga, 2010). EIBI programmes are typically run by a Board Certified Behavior Analyst (BCBA). To become a BCBA, practitioners must complete a Master's degree in ABA, have at

least 2,000 hours of supervised experience, agree to the ethics code, pass an exam set by the Behavior Analyst Certification Board (BACB), and access continuing education on the topic of ethics and behaviour analysis. In the UK, behaviour analysts are encouraged to join the UK Society for Behaviour Analysis (UKSBA) register. The UKSBA will take over the certification of UK-based behaviour analysts in 2026 (UKSBA, 2020).

The teaching of new skills often begins with discrete trial teaching (DTT), a highly structured teaching technique conducted with a 1:1 teacher-to-pupil ratio (Grindle et al., 2009). DTT can help learners acquire skills that they previously found difficult to master. Each trial begins with an instructional cue which lets the learner know what is expected of them, the learner responds, and a consequence is provided by the teacher. The consequence either provides corrective feedback or reinforcement of the correct response. These trials are run in quick succession to maximise learning opportunities (Leaf & McEachin, 1999). Skills learned in DTT are then generalised to the classroom so that they can be used in the context where they normally occur. Natural Environment Teaching (NET), which uses a child's motivation in natural situations to teach skills, is run alongside DTT. NET is used to improve generalisation and teach skills such as communication, play and social skills.

BCBAs use assessments and direct observation to determine a client's targets. Preference and reinforcer assessments are run to ensure that each learner is motivated to engage with the programme. Functional assessments are used to understand why a learner engages in a problem behaviour (Hanley, 2012), and helps provide suggestions for functionally equivalent replacement behaviours. Programmes are then created to teach the child an alternative response that they can use to meet their needs in a more appropriate way.

Data are an important aspect of EIBI, and they are taken on each target to track a child's progress. Often data are taken on each occurrence of a behaviour; this allows targets to be moved on quickly when they are mastered and changes to be made when the child is not progressing. To help staff implement the procedures, they are supervised regularly by more experienced practitioners and are given training on each technique.

What should EIBI look like?

It is recommended that a BCBA provide consultation for every 10 hours of programming (BACB, 2014), although each case should be judged individually.

Dixon et al. (2016) examined how EIBI supervisors' qualifications affect the number of skills learned. They found that when a BCBA supervised the programme the children mastered 73.7% more targets than when programmes were supervised by less qualified individuals. The intensity of supervision is also important; as the number of BCBA supervision hours increases, so does the child's resulting IQ change (Eikeseth et al., 2009). Dixon et al. (2016) suggested that limited gains in some UK research (Bibby et al., 2002; Magiati et al., 2007) may be partly explained by less frequent professional supervision. In these studies, supervision by a qualified professional was only provided every three months, on average. BCBA supervision needs to be more frequent to ensure that children make the improvements that are described in other studies.

EIBI programmes are usually implemented for 30 to 40 hours per week (BACB, 2014). Virués-Ortega (2010) examined several studies and found that children made more progress the greater number of hours of ABA provision they received; this was particularly true for language skills. While the intensity of EIBI is important, how the time is used is also significant (Linstead et al., 2017). Grindle et al. (2009) state that teaching in EIBI includes both DTT and generalisation. While DTT is an effective technique and can lead to rapid learning of skills, these skills need to be generalised to different contexts (MacDuff et al., 2001). One study which used relatively few hours of DTT, with more time allowed for generalisation, was Foran et al. (2015). In this study, seven hours of DTT were delivered per week and the rest of the week was spent generalising the skills during group lessons. Despite receiving fewer hours of DTT than in other studies, the children made significant progress in a range of skills.

Most studies look at the effects of an EIBI model over one or two years (Eikeseth et al., 2012; Eldevik et al., 2006; Foran et al., 2015; Grindle et al., 2012). Several authors have investigated the effects of intervention length (Makrygianni & Reed, 2010; Reichow & Wolery, 2009; Virués-Ortega, 2010). Some reviews found that a longer intervention duration was related to greater gains in some areas. Other studies found no connection between duration and child improvements. More research is needed to determine the effect that duration has on increasing skills.

Cost-effectiveness of EIBI

Rodgers et al. (2020) conducted a cost-effectiveness analysis of EIBI in the UK. The authors considered the cost of EIBI and the improvements in quality of life for the child as a result of the intervention. The estimated annual cost of providing EIBI was £36,682.78 based on a model described

in Griffith et al. (2012). This was considerably higher than the cost of TAU, which they estimated as being £8,689.78 for mainstream with support and £15,702.78 for a specialist placement per annum. The additional cost of EIBI was considered to outweigh the benefits of EIBI and did not reach NICE thresholds of cost-effectiveness. The EIBI costs are based on a programme at an independent Applied Behaviour Analysis (ABA) school, which few children in the UK access (Griffith et al., 2012). As noted, EIBI is only one type of behavioural intervention that can benefit learners. Other models of behaviour analysis should be considered, to bring down the annual costs of delivering an intervention based on behaviour analysis.

Home-based programmes

The predominant model in the UK is home-based programmes in which parents or local authorities pay privately employed ABA consultants and tutors to implement the programme (Bibby et al., 2002). ABA consultants oversee the programme by designing curriculum and teaching strategies, supervising tutors who deliver the teaching during 1:1 sessions, and providing training on behaviour analysis techniques (Child Autism UK, n.d.). Workshops are held by the consultant to assess targets and to train tutors to implement them. Home programme providers recommend that workshops are held at least once every six weeks (Child Autism UK, n.d.; Eikeseth et al., 2017), though the frequency is decided by the parents.

Parental involvement is a key element of home programmes, with parents often encouraged to implement behavioural techniques throughout the child's day. Parents can observe the techniques used during their child's sessions and apply them outside of intervention hours. This allows the child more opportunities to practise the skills, but also helps them to generalise these to other settings. Basing the programme in the home can make it easier to teach functional skills, such as washing and dressing. Sessions can be fitted around the child's schedule so that the skills can be practised when they would naturally occur. Early UK-based studies show promising results. Remington et al. (2007) found that children who participated in home-based EIBI for two years made greater improvements in language, IQ, daily living skills and positive social behaviour than those who had education as usual (EAU).

UK-based studies have had mixed findings on the long-term benefits of home-based EIBI. Remington et al. (2007) found that children on home programmes made good progress at the time, but these gains were not maintained

two years later (Kovshoff et al., 2011). However, another UK-based study (Smith et al., 2019) found that gains made during the intervention were maintained 10 years after the intervention. Skill acquisition has also been found to be slower in home programmes than in centre-based services. In a study by Dixon et al. (2017), twice as many learning goals were mastered when skills were taught in a centre than at home. Dixon et al. suggested that the better results in centres and classrooms may be attributed to easier access to supervisors, increased opportunity for generalisation, greater structure and it being easier to control the environment in centre-based services compared to home programmes.

Another difficulty with the home programme model is its sustainability. Home programmes are expensive, with a full-time programme as described in Smith et al. (2019) costing approximately £45,000 per year (Eikeseth et al., 2017). This figure is significantly higher than the costs of typical educational placements and presents few savings compared to the model examined by Rodgers et al. (2020). The high cost of each programme means that education providers may be unable to fund them for all the children who could benefit. Local authorities often contest any requests for these programmes to be funded, at least in part due to the cost of the programmes. If schools or local authorities are unable to fund these programmes for many children, an education that includes behaviour analysis can only be accessed by children whose parents can afford it or are willing and able to fight for the provision to be funded. If education based on behaviour analysis is to be integrated into mainstream provision, then more sustainable options need to be found.

School-based programmes

School-based programmes are another way to deliver a behavioural education. These programmes run within the school system by approximating the school day (Foran et al., 2015), using a typical class layout (Pitts et al., 2019) and school documentation (Grindle et al., 2009). This type of intervention has been implemented successfully in special and mainstream schools in the UK. The interventions are typically implemented by teaching assistants who have basic numeracy and literacy qualifications and may have other qualifications in related areas (Foran et al., 2015; Grindle et al., 2012; Peters-Scheffer et al., 2013). They often have no prior experience of ABA, but are given high-quality training and frequent supervision by behaviour analysts (Grindle et al., 2009). As the programme is implemented by classroom staff, the staff-to-child ratio is typical for the provision. The training and supervision of school-based staff by

BCBAs and other experienced members of staff are important to ensure the effectiveness of the intervention (Dixon et al., 2016). School-based behaviour analysis has a growing evidence base and is providing a cost-effective way for a behavioural education to be delivered.

Special schools

An example of a school-based study is that of Peters-Scheffer et al. (2013), where a behavioural education was provided at maintained special schools and pre-schools in the Netherlands. The children in the study were aged three to seven years at the onset of the intervention and had an average IQ of 40.66. They received five hours of 1:1 teaching based on behavioural principles, with the rest of the week spent generalising skills with the classroom staff. The intervention was implemented by school staff who received an initial two-day training workshop and on-going training. Supervision was provided by experienced practitioners for an average of 4.39 hours per week per child. The children's progress was compared to a group receiving EAU, which consisted of speech and language therapy, TEACCH and sensory integration therapy. The children in the behavioural group made more progress on measures of IQ, mental age, adaptive behaviour, inter-personal skills, play and receptive language.

Behaviour analysis has also been implemented in the UK; Foran et al. (2015), O'Boyle and Hoerger (2021) provide a model for ABA provision in a maintained special school, without need for major adjustments to staffing levels. The children in the study were aged three to five years at the beginning of the intervention and had a mean IQ of 48.85. Collaboration between the teachers and behaviour analysts was a key component of their model; the behaviour analyst worked with the teacher to set individual targets, and develop plans to increase behaviours that facilitate learning and decrease behaviours that interfere with learning. The teachers were responsible for classroom management and setting National Curriculum targets. The behaviour analysts provided training for the classroom staff and weekly supervision of each child. Classroom staff delivered the intervention using a ratio of 0.56 staff to every child. Seven hours of DTT a week was provided to each child, and the rest of the time was used for generalisation of skills in group lessons. The children made statistically significant gains on measures of IQ and in several areas on a developmental curriculum, including language and self-help skills. The challenging behaviour of two pupils was reduced with the use of function-based interventions.

Pitts et al. (2019) evaluated the outcomes of pupils in Key Stages 1 to 3 in an academy special school. The targets were implemented by the classroom staff

with a ratio of 0.6 or 0.7 adults per child. Behaviour analysts provided one day of consultation per class per week and delivered theoretical and practical training for the staff. The staff delivered five hours of DTT each week per child, with the rest of the time spent supporting the pupils using the principles of ABA. This included behaviour plans, communication targets and generalisation of skills learned in DTT. After one year, pupils in all key stages made significant gains on measures of language, adaptive behaviour, and social and academic skills. Further research is needed to compare the gains children make when this model is used to those made by children attending special schools without ABA input.

BCBAs and school staff work together to support the child in the special school model. The BCBAs work at the school; this allows for frequent support for staff and a close watch on all behavioural programmes. The BCBA works as part of a multi-disciplinary team, which allows for collaborations with other professionals, and the opportunity for the children to benefit from a more holistic, joined-up education. The behaviour programmes are implemented by all the classroom staff, giving the children more opportunities to generalise their skills to different people. The model makes few changes to the traditional special school model, meaning that there is little extra cost associated with incorporating behaviour analysis into the school and few changes to the school structure are needed. The only additional cost is the BCBAs, who are employed by the school. This model has fewer additional costs compared to the model described by Rodgers et al. (2020) and may meet NICE cost-effectiveness thresholds. However, this model has only been tested in a small number of schools. While the results suggest that the children make good progress, there are currently no studies showing the long-term outcomes for these children.

Unit at a mainstream school

One UK-based school study (Grindle et al., 2012) was conducted in a maintained, mainstream school. The children were aged three to five years at the onset of the study and had a mean IQ of 59.5. They received 1:1 support, as was set out in their educational statements. DTT was provided for an average of 15 hours per week, and the rest of the week was spent in group lessons in the classroom or with mainstream peers. When appropriate, the focus of the programme emphasised generalising skills and learning in the mainstream classroom. Each child worked with at least three staff members; they were trained by the BCBA who supervised the programmes fortnightly. National Curriculum targets were set by the ABA

class teacher. In the first two years, the children made significant gains in adaptive behaviour and on a developmental curriculum. Their progress was compared to that of autistic children who received EAU, and the ABA group made significantly more progress on measures of IQ and adaptive behaviour.

This model presents children with easy access to inclusion; they have access to a mainstream classroom where they can generalise their targets and work on independence skills. This provides an opportunity to move away from 1:1 teaching and to introduce more group learning. A mainstream unit is a collaborative exercise between behaviour analysts and teachers. This gives the children the benefit of accessing behavioural techniques that may help to address any skill deficits or problem behaviours and gives them access to the National Curriculum. The only additional cost associated with this setup are the ABA staff and, as such, this model may also meet NICE guidelines for cost-effective treatment. However, the model has been tested with relatively few children and there is a lack of data showing the long-term outcomes of this approach.

Mainstream schools

A behavioural education has also been successfully implemented in mainstream schools. Eldevik et al. (2006) examined a provision based on behaviour analysis at maintained, mainstream schools and nurseries in Norway. The children were younger than six years at the beginning of the study and had an average IQ of 41. They received 12 hours of DTT per week, and the rest of the week was spent with a 1:1 teaching assistant. School staff implemented DTT after attending a three-day workshop, and weekly supervision was provided by a behaviour analyst. The children's progress was compared to that of children receiving 12 hours of 1:1 EAU. The behaviour analysis group gained eight IQ points on average compared to a three-point loss by the EAU group.

A further study in Norway (Eldevik et al., 2019) looked at children receiving publicly funded behaviour analysis in pre-schools. The programme was provided at the child's local pre-school where the staff were trained to implement the programmes. The behaviour analyst visited weekly to update targets and train staff. Targets were set by the supervisor, with the amount of provision determined by the child's educational statement. The results show that those who received 18 hours per week made greater gains than those who received 11 hours per week. Both behaviour analysis groups

made greater gains than those receiving EAU. The authors noted that the behaviour analysis provision cost no more than EAU. This is a significant finding, given the concerns raised by Rodgers et al. (2020) about the cost-effectiveness of EIBI.

The mainstream model works within the typical provision for children with special educational needs and disabilities at mainstream schools. The school staff implement the intervention, while local authority staff provide consultancy to local schools. This falls within the usual level of funding of a 1:1 teaching assistant and top-up funding for input from an autism specialist. Therefore, it can be offered to all children who need it, and can be offered regardless of the economic status of the parents or of their prior knowledge of behaviour analysis. One difficulty with this model is that each new case requires the consultants to train the school staff. This creates a period when the school staff are not fully trained, and the child may not receive the full benefit of the ABA approach. It can also be difficult to spend enough time on ABA interventions when the school may have competing expectations (Eldevik et al., 2012).

Leicestershire County Council

In Leicestershire, the council employs a team of behaviour analysts to support work with children with autism and their teachers in their local primary school, special school or nursery at the parent's request. The team is led by a BCBA (the first author of this article) with experience of working on local authority-funded programmes in mainstream and special schools. The BCBA is supported by an assistant ABA consultant who has a MSc in ABA and a lead ABA tutor who is responsible for training new ABA tutors. When children have ABA provision outlined on their Education, Health and Care Plan, the school provides a teaching assistant to be trained as an ABA tutor. The tutors usually have experience of working with children with autism but have not implemented ABA programmes before. The staff receive eight days of training from the lead ABA tutor and complete a 40-hour Registered Behaviour Technician course outlining key ABA theory and techniques.

The children are visited fortnightly by an ABA consultant to update programmes and support the ABA tutor in implementing the targets. DTT is implemented for around one hour per day, with the rest of the day spent working on communication, behaviour interventions and generalising targets to the classroom. National Curriculum targets are set by the class teacher

and are implemented by the tutor and other members of school staff. As the child progresses, the focus switches to independence skills and integrating the child into the classroom. This model is inexpensive compared to home programmes, and costs around £6,000 more per child than typical provision in the first year and £4,000 more in subsequent years. School-based models, such as Leicestershire's, provide a sustainable model which can be used with a large number of children for relatively little extra cost. This addresses the issue raised by Rodgers et al. (2020) that EIBI was too expensive. This model puts in place a structure for ABA provision which can be replicated for each additional child. Leicestershire's model has yet to be evaluated specifically but is similar to models described in other published studies (Eldevik et al., 2019; Rivard et al., 2014).

Conclusion

In conclusion, behaviour analysis is an effective intervention for improving the skills of young children with intellectual disabilities (Eldevik et al., 2009). A recent study (Rodgers et al., 2020) found the EIBI model is not cost-effective when delivered using an ABA school setup. The EIBI model involves a young child working 1:1 with trained tutors for 30 to 40 hours per week over a period of two years. However, several school-based models are used in the UK and offer a lower-cost provision with promising results. Another benefit of the school-based model is that the behaviour analysts are line-managed by the school or local authority, and the model encourages multi-disciplinary collaboration. These models have been successfully implemented in maintained special and mainstream schools. School-based models lead to good outcomes for the children in the short term, but require schools to make few changes to incorporate a behavioural approach into their setting. These models provide schools with a cost-effective way to implement ABA. More research should be carried out on school-based behaviour analysis to assess the long-term benefits of these models. There is very little research in the UK that evaluates specialist provision for young learners, and we welcome further research that considers how a behavioural approach can be used alongside more commonly used teaching models.

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