Meeting vision needs of children with special educational needs:

Case studies of the impact on behaviour and academic achievement

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Accepted 20 Dec 2019 in *British Journal of Learning Disabilities*

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Data available on request due to privacy/ethical restrictions from Prof Karola Dillenburger, Centre for Behaviour Analysis, Queens University Belfast,

Running title: VISUAL NEEDS OF CHILDREN WITH SPECIAL EDUCATIONAL NEEDS

This study was funded by Action Medical Research (GN2429), the Vision Translational Research Group (HSC R&D Office, NI) and postgraduate research support from Ulster University and the Department for the Economy. Views expressed are the authors'.

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Abstract

Background: Children with identified special educational needs are at higher risk than other children of having visual needs that are not adequately met. This paper evaluates the impact of addressing the visual needs of these children on behaviour and academic achievements in a number of case studies.

Method: Nine children (4-11 years of age, from four classrooms), who attended a special school in a medium sized town in the UK, took part in the case studies reported here. The children were part of the Special Education Eyecare (SEE) Project. Six of the children were selected because they had unmet visual needs at baseline and required bespoke interventions to meet these needs; the other three children were selected because their visual needs had been met prior to the study and no further adjustments were needed. Repeated direct observations were conducted to assess the impact of the intervention on the children's behaviour in the classroom. The observer was 'blind' with regard to the visual needs of the participants. Parents and teachers completed the Strength and Difficulties Questionnaire (SDQ) for each child, before and after the intervention. School files were analysed to assess effects on academic achievement.

Findings: Subsequent to the implementation of bespoke visual adjustments, e.g., prescription of spectacles or changed seating in classroom, significant and sustained changes were observed with regards to the children's behaviour (i.e., increased engagement with peers and/or teachers and decreased off-task behaviour). SDQ scores showed improvements regarding total difficulties, emotional difficulties, hyperactivity and prosocial (kind and helpful) behaviour. Due to highly variable data in school files, the effects on academic achievement were inconclusive.

Discussion: The case studies reported here explored changes in behaviour of children with identified special educational needs after their visual needs were met. Findings show a positive overall effect on the behaviour of these children.

Key terms: Special education; vision; visual needs; in-school vision testing; behaviour measures; SDQ; applied behaviour analysis.

The prevalence of visual disorders in children who have identified special educational needs is known to be greater than in their typically developing peers (Little & Saunders 2015; Woodhouse et al., 2014; Das et al., 2010). Children without developmental disabilities have a much lower risk of visual impairment (0.16% compared to 10.5%) as well as other vision disorders (Salt & Sargent 2014); children in special schools have reported prevalence of visual impairment between 12%-16% (Little & Saunders 2015). It is estimated that up to two-thirds of children with visual impairments have other identified special educational needs, co-occurring most frequently with neurological or developmental conditions such as autism, Attention Deficit/Hyperactivity Disorder or epilepsy (Morale et al.2012; Bitsko et al., 2009).

However, in children with complex needs visual disorders can be difficult to identify and assess (Salt & Sargent 2014). Although specific guidelines for vision care exist, there is evidence that visual care for children with special educational needs is frequently neglected (Pilling, 2011; Woodhouse et al., 2014). These children also experience barriers to accessing eyecare services in hospital or community optometry settings, partly because the stress of unfamiliar surroundings and communication difficulties can make cooperation in such situations challenging (Das et al., 2010).

A relationship between visual deficits and impaired academic performance has been demonstrated repeatedly, both in mainstream and in special schools (Toledo, Paivo, Camilo, Maior, Leite & Gaiva, 2010; Dudovitz et al., 2016). Consequently, it is possible that appropriate vision correction for children with identified learning disability results in improvements across a range of behaviour, including social behaviour, gross and fine motor skills, and academic achievements, e.g., in literacy (Nandakumar & Leat, 2010; Bader & Woodruff, 1980). Conversely, unaddressed visual conditions can have long-term adverse implications for quality of life and lead to challenging behaviour in adulthood (Jones et al. 2008).

Vision assessment that actively involves parents, children, and teaching staff addresses not just issues regarding the child's visual difficulties but also their educational, developmental, health, and social outcomes (Dudovitz et al. 2016). This holistic approach is welcomed by parents and teachers (Little & Saunders 2015; Woodhouse et al. 2014) and contributes to reducing stress for parents and children (Morale et al. 2012).

Research reported in the present paper was part of the large-scale Special Education Eyecare (SEE) Project (Black et al., 2019). The SEE project included 200 children and young people (4-18 years of age) with identified special educational needs, school staff, and parents/guardians in a comprehensive in-school vision assessment programme. Following the visual assessment, parents and teachers received a comprehensive report with detailed information about each child's visual status and, where relevant, jargon-free advice on how to address previously unmet visual needs for each of the children. The in-depth case studies reported here offer an analysis of the effects of this on the children's behaviour in the classroom and at home and their academic achievements.

Methodology

Ethical approval was granted by relevant Research Ethics Committees of Ulster University and Queens University, Belfast. The research was conducted in line with the research governance and data protection guidelines for both universities. This included parental consent for vision assessment, questionnaires, as well as file research. The children's names were changed to preserve anonymity.

Participants

Nine pupils (3 girls and 6 boys) from four classes took part in in-depth case studies. The sample ensured opportunity for repeated in-vivo observations in a relatively short time span. The children's ages ranged from 4 years 5 months to 11 years 8 months of age. Six of the children (3 girls and 3 boys) required adjustments to support their visual needs and three of the children did not require additional interventions according to comprehensive eye examinations (Table 1). The children were a representative sample (based on their visual needs profiles) selected from participants in the larger SEE study. The children for the case studies were chosen by the 'vision team' of the SEE study to ensure that the 'behaviour team' were unaware of (blinded to) the vision needs of each case study child, until after data collection was completed.

Research tools

Behavioural observation recording sheets: The observation recording sheet was adapted from the interval recording sheet developed by Coyle and Dillenburger (2018; Dillenburger & Coyle, 2019). This recording sheet listed a number of 'observable, measurable, and specific' (Nock & Kurtz, 2005, p. 362) target behaviours to be observed in all children, regardless of their age, level of learning disability, or teaching environment.

The target behaviours were as follows:

- Being on-task, including initiating engagement with peer and/or teacher/teaching staff, either verbally, by sign or by touch;
- Being off-task, such as being disengaged from the set task or engaging in non-task-related behaviour, including playing with toys or equipment, delaying log-on to computer, staring out of a window or at a workbook without engaging in the task, distracting other children, and direct non-compliance (e.g. refusing to complete a task, eating a snack instead of working), and being out-of-seat;
- Receiving a positive comment from a member of staff (e.g. 'nice work' or 'well done');
- Repetitive stereotypic behaviours (e.g. hand flapping, rubbing eyes, rocking in seat);

To the right of each of the target behaviour were 10 small boxes, each representing 1-minute observation intervals, in which each occurrence of the behaviour was tallied (e.g., ~~IIII~~ representing a

count of 5 occurrences of the behaviour). Thus, the frequency of each behaviour was counted across the ten one-minute observation periods for each child. At the bottom of the observation sheet there was blank space to record field notes about events that occurred during the observation period, e.g., interruptions to class, specific interactions, child's position in classroom with respect to screens, play areas etc. Field notes also specified the antecedents and consequences of the target behaviour (Nock & Kurtz, 2005). There also was a 'yes/no' tick box to record if the child was wearing spectacles.

Strengths and Difficulties Questionnaire: The Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001) is considered a robust and well-validated instrument to assess behavioural issues in children and young people across time (Muris, Meesters & van den Burg, 2003; Rothenberger et al., 2008; Stone et al., 2010; Wolpert, Gorzig, Deighton, Fugard, Newman & Ford, 2015). It is completed by parents or teachers and comes in short and extended versions. The extended version used in this study has 25 core questions and a supplement that focusses on the impact and the duration of reported problems and difficulties (Goodman, 2001). The follow-up SDQ, administered after any intervention, contains two additional social validity questions regarding the respondent's views of the intervention.

Academic attainment scores: Files held in the school for each child were used to assess academic scores (e.g., spelling and maths) across time. Data contained in the files were collated annually in the school (Wyers, 2018), using tests for spelling and maths. Spelling tests included the Diagnostic Spelling Test series (Crumpler & McCarty, 2006), Daniels and Diack Spelling Tests (Daniels & Diack, 1958), Vernon Graded Spelling Tests (Vernon, 2006), and/or the InCAS, a computer-adaptive assessment to identify and diagnose learning need and measure progress in key developmental areas (CEM, 2019). Maths tests included the Numeracy Baseline Test (NBT)/Numeracy Progress Test (NPT) (Vincent & Crumpler, 2000), Young's Group Test A (Young, 1996), and/or the InCAS (CEM, 2019). Special educational needs statements (the Northern Irish equivalent of Education, Health and Care Plans) were available in the files. These were used to record the level of support needs for each child.

Research procedure

Participant selection. The nine children included in the present study constituted a carefully selected sample from the SEE Project population (n= 200) (Black et al. 2019). The SEE project took place over two academic years in a large special school in a mid-sized town in Northern Ireland and included very thorough in-school vision tests, a bespoke visual needs report for parents and teachers, behavioural screening (parent and teacher SDQ), and two brief in-vivo classroom observations, one before and one after the vision intervention. Due to wide variations in the school timetable, it was not possible to obtain longitudinal data of all the children and therefore the small sample of children (n=9) was selected for in-depth case studies.

To prevent selection bias, the 'vision team' selected the children for the case studies without disclosure to the 'behaviour team' of whether or not the child required visual adjustments. Decoding occurred after completion of all observations and other data collection.

Visual and ocular health assessment: Vision and ocular health assessments were carried out twice. Once at baseline and again 2-5 months after the necessary adjustments had been recommended. The tests included measures of visual acuity using tests appropriate for the participant's age and ability and following standard test protocols; contrast sensitivity; accommodative function; ocular alignment; ocular movement assessment; binocular visual field measurement; refractive error; and dilated internal and external ocular health assessment. The tests led to two main recommendations: (1) the need for a new spectacle prescription, and (2) modifications to the learning environment (e.g., seating near the front of the class, employing large print material). Full details of the tests and test results are provided elsewhere (Black et al., 2019).

Behavioural observations. Using the behavioural observation recording sheet, total of eight 10-minute observation sessions (total 80 minutes) were carried out for each of the 9 case study children. This included one baseline observation session (Obs.1) prior to the visual and ocular health assessment and seven observations after the visual and ocular health assessment had occurred and adjustments had been recommended (Obs.2-Obs.8). The time span between the first (baseline) and the final observation ranged between 26 and 30 weeks (average 28 weeks).

For the behavioural classroom observations, arrangements were agreed in advance with the relevant teacher. The observer sat at the back of the class to prevent the Hawthorne Effect, i.e., to ensure that the participants' behaviour was not affected by the observer's presence (Johnstone & Pennypacker 2009). The observer had full visual of the child being observed throughout the session (Martin & Bateson 2007).

Classroom layout and activities and any additional unstructured observations were recorded in freehand field notes at the bottom of the observation sheet, and included observations related to potential recommendations, such as was the child wearing /not wearing spectacles; was the child seated at the front of the class; and/or was enlarged print used (the observer was not aware of the specific visual recommendations for the child at the time of observation). Inter-observer agreement (IOA) measures were not possible due to the fact that, due to concerns about disruption to teaching, permission was not granted by the school for a second observer to be present in the classroom. Video recording, that would have allowed for post-session IOA calculations, also was not permitted.

The children took part in a range of classroom activities and observations were scheduled to occur under conditions that were similar with regards to classroom, learning activity, time, and day of week, within the natural constraints of school timetables and resources. The two youngest children (Luke and Billy) were involved in a combination of desk-top activities, such as counting or reading one-to-one with the support of a teaching assistant, free play, or whole class activity time, such as singing, 'weekend news' or watching videos with all pupils seated in front of a large screen. Both

children engaged in a number of activities (including periods with no set tasks) over the ten-minute observation; Luke engaged in an average of 3.4 activities, with a maximum of 5 activities per session, while Billy was occupied with an average of 2.6 activities, with a maximum of 4 activities per observation session. The older children were engaged in subject-based, whole class teaching either in English or History. Aine and Ciara received frequent support from teaching staff to complete tasks; Timothy worked independently, receiving occasional teacher support, e.g., to answer a query. Shane needed consistent support to complete tasks as his motor skills were very poor, although support was not always available. Rose worked independently, on two occasions with a peer in group work, receiving occasional support. Two children (Conall and Alan) were observed during maths classes in all observation sessions. After the first observation, Conall was moved to a separate learning zone at the back of the classroom with another pupil, where they were supported by a classroom assistant for most of the lessons. Alan was observed while he worked independently, receiving occasional support from his support teacher. All other children were observed in a classroom, while they were taught by their class teacher.

Strength and Difficulties Questionnaire: Parent SDQs were completed by telephone interview. The researcher rang the parent at a pre-arranged time and read out the questions, one at a time, and recorded the parental response to each question on the SDQ form. Hard copy SDQs were available on request (no such request was made).

Teacher SDQs were completed in the school. The case study children were drawn from four classes and the teaching staff who knew the child best completed an individual SDQ for each child; this was either the class teacher (for younger children) or the form teacher (for older children). Both parent and teacher SDQs were administered twice for each child; once before and once after the vision assessment and report. All parents (n=9) and teachers (n=4) completed the relevant SDQ, although baseline Teacher SDQ data were incomplete for Conall and Alan.

File Search: A search of records held in school files was conducted for each of the children (Carroll & St Peter, 2014). The file search took place in the school office. The door was locked while the files were searched. None of the files were taken out of this room and on completion of the file search, the files were placed back in a locked filing cabinet.

The files included a written record of the results of the annual review for each pupil. Annual reviews were conducted by the teachers at the beginning of each academic year and resulted in a child's numerical 'attainment age' for each subject studied. Annual reviews were not carried out for a number of children; those in pre-school (3-4 years old), Year 1(4-5 years old), Year 2 (5-6 years old) and children with severe learning disabilities. The data retrieved from the files included attainment age with regards to spelling and numeracy as well as the child's chronological age. Pre- and post-intervention records were incomplete for 8 of the children. A full data set was available for one child (Timothy) (Table 6).

Results

Adjustments to meet visual needs: The vision assessment led to spectacle corrections being prescribed for three children; Shane had never had spectacles and both Luke and Alan had been prescribed spectacles in the past, but neither had worn them. Two children (Áine and Rose) had spectacles prior to the study and wore them full-time; no changes to their spectacle prescription or wearing schedule were recommend in the vision assessment. The other children did not require spectacles.

Three children (Luke, Áine, Rose) wore their spectacles during all post-baseline observations. Alan did not wear his spectacles at any time, although they were placed on his desk during some of the observations. Shane wore his spectacles for five out of the seven follow-up observations. He had very limited fine motor skills and needed assistance to retrieve his spectacles from a school bag and put them on. In all cases where modifications to the learning environment had been advised following the visual assessment, teachers had implemented these strategies.

Engagement with staff or peers: Table 2 shows the frequency of child-initiated engagement with staff or peers during direct observations, both at baseline (Obs.1) and follow-up (Obs.2-8). For five of the six children who required vision adjustments, the frequency of initiating contact with staff or peers increased post-intervention. Before the visual assessment, these children instigated interaction an average of 2.5 times (range 1-6) each per observation. After visual assessment, the children's interaction with peers and teacher increased to an overall average of 3.3 times (range 0-11) per observation period (Obs.2 to Obs.8). The three children who did not require visual adjustments (Billy, Timothy, Conall), initiated an average of 4 interactions (range 0-9) prior to their vision assessment (Obs.1), this rose slightly to an average of 4.2 interactions (range 0-13) across subsequent observations (Obs.2 to Obs.8).

Off-task behaviour: Table 3 shows the frequency of off-task behaviour observed before and after the visual assessment. For the six children whose visual needs were unmet at baseline (Obs.1), the average off-task behaviour decreased after adjustments had been made to meet their visual needs. On average, these children were off-task 1.3 times (range 0-4) at baseline. After the vision intervention, off-task behaviour reduced to an average of 0.9 times (range 0-4) per 10-minute observation (Obs.2 to Obs.8). Field notes made by the observer indicated that more off-task behaviour occurred at the start of an activity or when the children being observed were engaged in a task that they found difficult and support was not available (such as logging in or searching on the computer when staff were engaged with others). For the three children who did not require any modifications after the vision assessment, off-task behaviour averaged 3 occasions (range 2-4) during the first observation (Obs.1) and remained 3 during the latter observations (Obs.2 to Obs.8), although the range increased (range 0-8).

Teacher comments: Table 4 shows the frequency of positive teacher comments before and after the vision intervention for all nine children. During the first observation (Obs.1), children who had unmet visual needs received an average of 1.3 (range 0-3) positive teacher comments. Following adjustment to meet their visual needs, during Obs.2 to Obs.8, the frequency of positive teacher comments rose to an average of 2.2 (range 0-13) comments per observation for each of these children. For those children who did not require modifications to accommodate visual needs, the average of positive teacher comments rose from an average of 1 (range 0-3) comment (Obs.1) to 3.3 (range 0-11) comments per observation session (Obs.2 to Obs.8). Positive teacher comments were unevenly distributed between the children and the classes they attended. Both Luke (range 2-13) and Billy (range 0-11), who attended the same class, received particular high levels of positive comments, while Shane (range 0-1) and Rose (range 0-1), who attended a different class, received very infrequent positive teacher comments, although they were very rarely off-task. Field notes indicate that Luke and Billy received most of these positive comments during one-to-one support for academic tasks.

Repetitive behaviours: Table 5 shows the frequency of repetitive behaviours. For the children who required adjustments, repetitive behaviour increased from an average frequency of 0.7 (range 0-2) (Obs.1) to 2 (range 0-10) per observation period (Obs. 2 to Obs. 8). For the children who did not require visual interventions, only Billy showed any repetitive behaviours during observations and these were sporadic. Field notes indicated that Alan engaged in repetitive behaviours most often and across a greater time period than others; more episodic events occurred for Luke, especially when he was left without a task (Obs. 7). Ciara and Áine both had neurological conditions which could lead to a fairly constant movement of hands or legs at times, while engaged in tasks. The observer was not aware of their condition at the time of the observations. These movements were not included in the analysis of 'repetitive behaviours' as it would be very difficult to ascertain their aetiology.

Strength and Difficulties Questionnaire: Figure 1 shows parent and teacher SDQ scores pre- and post-vision assessment for each of the children. The figure shows scores for total difficulties, emotional difficulties, behaviour difficulties, hyperactivity and concentration difficulties, peer problems, pro-social behaviour, overall impact, and compares these with British norm scores (SDQ, 2001). Most of the children in the present study scored 'slightly raised' or 'high' scores in many of the categories. Some of these scores reduced for the children who required adjustments to support their visual needs after these needs were met.

Total difficulties: The total difficulties score reported by parents for the children who required vision adjustment improved by an average of 3.3 points. Teacher-reported total difficulties scores for these pupils improved by an average of 0.8 points. Only Ciara's total difficulties score at school worsened to slightly above the norm for her age group. For the children who did not have unmet visual needs at the start of the project and who therefore did not require additional adjustments to support their vision needs, parent-reported difficulties improved by an average of 2.3. However, this score was still well above normative UK scores for children of their age. Teacher-reported total

difficulties scores for two of these children (Billy and Alan) worsened by an average of 4.5; no comparative data were available for Conall.

Emotional difficulties: For three of the children who received vision adjustments, emotional difficulties scores improved at home; this was particularly noticeable for Alan, although his and Rose's scores remained above the norm for their age. Slight worsening in scores was recorded for two of these children; Luke's score remained within the average range, but Ciara's score moved from 'raised' to 'high'. In school, improvements in the emotion scores were recorded by the teachers of four of these children, with only Ciara showing a slightly worse score than at baseline. Two of the children who did not require vision adjustments (Billy and Timothy) had slightly enhanced emotion scores at home, while a deterioration in scores to a 'high' level was reported for Conall.

Behaviour difficulties: Two of the children (Luke and Alan) who received vision support had somewhat improved conduct scores at home, although these were still above the norm for boys of their age. For Áine and Rose scores remained stable, while for Ciara and Shane the scores indicated slightly increased parental concerns about behaviour difficulties. Teacher scores indicated that for Luke and Rose, behaviour difficulties had decreased; this was particularly noticeable for Rose, whose initial score was above the norm but reduced to zero after vision adjustments. Scores for Áine, Ciara, and Shane remained stable. Insufficient teacher-reported data were available for Alan. On the other hand, of the children who did not need additional vision support Billy showed worsening behaviour difficulties at home (well above the norm for boys of his age) and Timothy showed worsening behaviour at school; although no initial data were available, his follow-up SDQ indicated Conall's behaviour at school was a concern, scoring considerably above the UK average.

Hyperactivity and concentration difficulties: Four of the children who received additional adjustments to meet their visual needs showed improvements with regards to levels of hyperactivity and concentration difficulties at home, although their scores remained higher than the UK average. In school, teacher scores also indicated an improvement for four of these children, e.g., from the limited data available from his partially completed initial SDQ, Alan's score improved from 'very high' to 'slightly raised'. Parental SDQ scores for one of the three children who did not require additional vision adjustments (Timothy) showed an improvement over time, but for Billy, hyperactivity and level of concentration scores worsened at home. Teacher scores for all of these children categorised their levels of hyperactivity and concentration difficulties as 'very high', with no major changes being recorded over time.

Peer relationships: Parental scores for one of the children (Rose) who received additional visual supports indicated much improved peer relationships while only Shane's parent reported worsening of peer problems for their child, although the score was still less than the UK average. Parental scores relating to peer problems of the children who did not require additional vision support improved for Billy and Timothy and worsened for Conall.

Teacher scores indicated that four of the children who required visual modifications had few problems with their peers prior to the assessment, no score was available for Alan. Following vision adjustments, a positive change in peer relations was recorded for Luke, while small deteriorations in peer relations were reported for Shane and Alan, although the scores were still below the UK norms for both children. Teacher scores indicated that Luke had decreased peer problems, while Shane and Alan had increased problems with peers; data were missing for Conall.

Pro-Social (kind and helpful) behaviour: For three of the children who received additional vision supports social behaviour scores increased at home and for Luke they improved at home and at school. A small deterioration was recorded for Shane. The pro-social behaviour of children who did not need further modifications to meet their visual needs stayed the same or improved slightly, with the exception of Billy at home, where his pro-social behaviour worsened, although his school score remained at zero.

Impact: The total impact score for children who required vision adjustments improved by an average of 0.08 points. For two of these children the score improved at home and for three of the children the impact scores improved at school; particularly for Luke. For the children who did not require additional modifications to support their vision, the total impact score worsened by an average of 0.33 points. This was particularly true at home, where the impact score deteriorated for all of these children, while at school the scores worsened for Conall as well.

Academic attainment: Academic attainment was measured by comparing chronological age to test/attainment age and noting the deficit in years. Table 6 shows all available academic attainment data retrieved from school files across 1-4 school years. The test age was lower than the chronological ages for all of the children in all of the tests, although data in the files were patchy and no academic scores were included in any of the files for Luke, Billy, or Shane.

For Áine data were available for only one year and only for maths (deficit of 3.34 years), therefore progress could not be assessed. For Ciara, data were available for two non-consecutive years for maths and showed an increase in deficit years, meaning that her math skills regressed despite three years of schooling. For Rose there was only one set of data for spelling, but for maths, her test age improved more than a year for one year of schooling, from a deficit of 4.41 years to a deficit of 3.25 years. For Alan, data were available for two consecutive academic years and showed significant regression in spelling; an additional year deficit (from a deficit of 1.58 years to a deficit of 2.58 years) as well as a year and a half additional deficit in maths (from 4.75 years to 6.33 years) despite the fact that he was prescribed new spectacles for the first time.

Timothy was the only child for whom the full 4-year data set was available for spelling as well as math attainments. No new vision adjustments had been recommended for Timothy. Overall his recorded results showed a lack of consistency; in the years of the study, his academic attainment scores for spelling worsened significantly, from 1.92 to 3.26 deficit years for the time span of the study, while his maths scores had suffered significantly in the year previous to the study (an increase

in deficit years from 1.50 to 3.34 years) but improved slightly (to 3.09 deficit years) in the years of the study. For Conall, who required no additional visual adjustments, data were available only for one year for spelling, while his maths attainment scores improved dramatically during the years of the study, albeit from a very low starting point (from 7.42 to 4.84 deficit years).

Discussion

Unrecognised visual needs can impact negatively on a child's development, cognitive and motor functions as well as physical wellbeing, social interaction and academic attainment (Morale et al., 2012; Roe, 2012; Dudovitz, Izadpanah, Chung & Slusser 2016; Salt & Sargent 2014). It is, of course, important to meet visual needs for all children but it can be particularly difficult to achieve for children who have additional identified special educational needs. Nine case studies were carried out to gain a detailed picture of the effects of whole-school vision and ocular health assessments and bespoke recommendations for visual adjustments (cf., SEE project; Black et al., 2019). Data included repeated direct classroom observations, parent and teacher reports, and academic scores. Six of the case study children required visual adjustments, such as new spectacle correction or specific seating arrangements in class, while the visual needs of three of the children had been met prior to the vision assessment and therefore these children did not require additional visual adjustments.

This study was conducted in the 'real world', where research required flexibility and methodologies need to be tailored to the realities of often complex contexts (Robson & McCartan, 2016). The SEE Project included only two classroom observations for each child (Black et al., 2019). Clearly, a one-probe baseline observation does not constitute a stable baseline and a once off post-intervention observation does not allow for individual conclusions about long-term effects on a single child. However, in the context of the whole-school SEE Project (n=200 children; Black et al., 2019) brief probes yielded statistically significant results, i.e., statistical analysis revealed that the vision intervention had an overall effect on this large group of children of significantly decreasing off-task behaviours and improving (all be it not statistically significant) one-task and social communication behaviours.

With regards the nine case study children reported here, the SEE Project methodology was adjusted to include repeated observations (a total of 8 observations per child) and an extended observation period (over 28 weeks) and thus to allow for a more in-depth analysis of long-term behaviour patterns. For Luke, Shane, and Alan, who were identified as needing spectacles to meet their vision needs, it became apparent that they needed behavioural supports to comply with their new prescription. Luke needed little encouragement. He wore his new spectacles consistently in school and parents reported that he also wore them at home. In contrast, Shane, however, who had fine and gross motor co-ordination difficulties required staff or peer support to put on his spectacles. The observations revealed that there were times when his spectacles remained in his school bag or they fell off his nose and no-one helped him put them back on. Shane's case is unlikely to be an exception

and therefore, findings reported here should alert teaching and support staff as well as children's peers to pay attention and help a child like Shane. Alan's case was different. He did not wear his spectacles at all. He would require bespoke positive behaviour interventions to ensure he wears his spectacles and thereby access better learning opportunities (Cooper, Heron, & Heward, 2007).

Furthermore, direct observations revealed that visual adjustments led to improvements on a number of levels. One of the key improvements was the frequency with which the children initiated interactions with peers and teachers. For example, Shane, who had no vocal speech, increasingly attracted the attention of his peers through physical contact, such as holding their hands. In turn, his peers responded appropriately to conversations with him, by smiling and making eye contact. Luke, who also had communication difficulties and generally engaged in solitary play, initiated engagement with peers most frequently during a short period of structured play supported by a classroom assistant. On one occasion, this was particularly pertinent as it followed a dispute with a peer.

The children who did not require additional visual supports showed a brief increase in terms of initiating communication and interactions after the vision assessment, however, this did not last and decreased again to levels similar to baseline. Conall engaged with another pupil, who was seated next to him in a separate working zone; both children were supported by a classroom assistant. Billy's engagement with peers and staff showed a small improvement after visual screening but remained very low. Timothy was able to engage confidently with his peers although the rate of initiation reduced somewhat after the visual assessment.

The frequency of off-task behaviours decreased notably for the children who received visual adjustments, consistent with the findings of the larger SEE Project group (n=200) that reported statistically significant decreases in off-task behaviour when the children's vision needs had been met (Black et al., 2019). These findings are consistent with research for typically developing children, that showed the effects of in-school provision of corrective spectacles to be positive, in particular with regards to improved attention, on-task behaviour, and compliance in academic tasks (Dudovitz et al., 2016).

For the children who did not require additional adjustments, off-task behaviour briefly reduced after the assessment, only to increase again to baseline levels. In fact, off-task behaviour increased markedly for two pupils who had not received a visual intervention, for example, when Conall was presented with a difficult task, he was argumentative and off-task behaviour occurred frequently. As such, the increased attention each child received due to the visual assessment appeared to have had a short-lived positive effect on their communication and off-task behaviours, while the fact that nothing changed for these three children after the assessment, meant that their behaviour returned to baseline levels.

The average frequency of positive comments from teaching staff increased over time. The reason for this remains unclear, however it is feasibly explained by the fact that, unlike the children, teaching staff were aware of reasons for the observer's presence. Therefore, these findings may reflect

a Hawthorne effect with regards to the teachers (McCambridge et al., 2014). However, the spread of positive teacher comments was very inconsistent. Some children received high levels of teacher comments while others received very little positive feedback from teachers. For example, Luke, Alan, and Billy received intensive one-to-one support from teaching assistants during table top activities. This obviously increased the potential for staff /pupil interaction and for positive feedback, especially when compared to pupils who mainly worked independently, such as Rose and Ciara who were expected to work independently, e.g., using set texts. Their on-task observations indicated that they were working consistently receiving very few prompts or comments from teachers, in part explainable by teaching methodologies that focus on independent learning skills.

With regards to overall behaviour difficulties, SDQ results reported here confirm that children with intellectual disabilities are more likely than other children to have elevated SDQ scores (Hysing et al., 2007; Kaptein et al., 2008). Obviously, the small number of case study children did not merit statistical analysis, however, findings indicated that meeting the visual needs had a small positive effect in terms of the children's overall strengths and difficulties. Of course, it is possible that parent and teacher perception of the children was influenced by the mere fact that the children had undergone a vision assessment and they had received a comprehensive and accessible report and feedback. This interpretation is supported by the fact that parents and teachers reported that they found the assessment and report useful.

With regards to the academic scores, clearly, the educational profile of the case study children was heterogenous and was largely due to the range and severity of their learning disability and their level of functioning and academic testing policies and practices with regards to younger children or those with more severe learning disabilities. Consequently, the range of tests used, abilities assessed, and frequency of assessment rendered a full assessment of the impact of the intervention on academic scores impossible. For example, for Rose's spelling data were only available for one year, while her annual maths scores showed improvements of more than a year for one year of schooling. It is possible that her spelling had also improved and that her vision adjustment (i.e., to reduce crowding, change seating position; see Table 1) played a part in this progress. Alan significantly regressed in terms of his spelling scores which evidenced the importance of not only capturing these data, but also keeping a close eye on them over the years. Alan was prescribed new spectacles for the first time, but his relatively poor academic scores may not be surprising, because Alan did not wear his spectacles at all during the study, despite the fact that they were placed on his desk. Future research should focus on the consistency in academic measures used as well as behavioural interventions to support the utilisation of visual supports, such as spectacles.

Conclusion

For children with identified special educational needs, vision problems are often overlooked (Woodhouse et al., 2014; Little & Saunders 2015). It is well recognised that visual deficits can act as barriers to learning (Salt & Sargent, 2014) and social inclusion (Roe 2012), in fact, children with vision deficits are frequently misdiagnosed as having learning difficulties (Salleh & Ali, 2010).

Findings reported here support the drive to combat health and educational inequalities through in-school vision testing (Black et al., 2019). They show that bespoke visual adjustments are beneficial and can lead to improvements in behaviours, particularly in terms of initiation of peer-engagement, reduction in off-task behaviours, and reduction of overall behavioural difficulties.

However, this paper also illustrates the complexity of what at first may seem like a fairly straightforward objective. Establishing a correlation between vision assessment and meeting previously unmet visual needs and child behaviour and academic achievements is a complex task that requires collaboration between the vision and the behaviour analysis research teams, parents, and teachers. As evidenced in cases where spectacles were prescribed for the first time, effective visual supports depended not only on identifying need correctly, but also on the behavioural support provided to ensure that recommendations were carried out, both in school and at home. In sum, findings reported here show what can be achieved when parents and teachers work together with eye care and behaviour analysis teams to meet the visual needs and thereby enhance learning opportunities of children with identified special educational needs.

References

Black, S. A., McConnell, E. L., McKerr, L., McClelland, J. F., Little, J. A., Dillenburger K., Jackson A.J., Anketell P.A., & Saunders, K. J. (2019). In-school eyecare in special education settings has measurable benefits for children's vision and behaviour. *PLOS ONE*. https://doi.org/https://doi.org/10.1371/journal.pone.0220480

CEM. (2019). *InCAS*. Centre for Evaluation & Monitoring Retrieved March 26, 2019, from https://www.cem.org/incas

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis*. USA: Pearson Prentice Hall.

Coyle, C., & Dillenburger, K. (2018). The Good Inclusion Game (GIG): Effective practice for inclusive education. *Academia Journal of Educational Research* 5 (3), 1-8. *Retrieved from https://academiapublishing.org/print/Coyle and Dillenburger.pdf*

Crumpler, M. & McCarty, C. (2006). *Diagnostic Spelling Tests: A Primary Manual*. London: Hodder & Stoughton.

Daniels, J. C. & Diack, H. (1958). *The Standard Reading Tests*. St. Albans: Hart-Davis

Das, M., Spowart, K., Crossley, S. & Dutton, G.N. (2012). Evidence that children with special needs all require visual assessment. *Archives of Disease in Childhood* 95, 888-892.

Department of Education for Northern Ireland (1998). *The Code of Practice on the Identification and Assessment of Special Educational Needs*. Available from https://www.education-ni.gov.uk/sites/default/files/publications/de/the-code-of-practice.pdf. Accessed February 12th,2019

Dillenburger, K. & Coyle, C. (2019). Education for all: The Good Inclusion Game (GIG). *Behavioural Interventions*. DOI: 10.1002/bin.1671. *Retrieved from https://onlinelibrary.wiley.com/doi/10.1002/bin.1671*

Dudovitz, R.N., Izadpanah, N., Chung, P.J. & Slusser, W. (2016). Parent, Teacher, and Student Perspectives on How Corrective Lenses Improve Child Wellbeing and School Function. *Maternal and Child Health Journal* 20, 974–983.

Goodman, R. (2001). Psychometric Properties of the Strengths and Difficulties Questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry,* 40 (11), 1337-1345.

Hysing, M., Elgen, I., Gillberg, C., Atle Lie, S., & Lundervold, A. J. (2007). Chronic physical illness and mental health in children. Results from a large-scale population study. *Journal of Child Psychology and Psychiatry,* 48, 785–792.

Johnston, J.M. & Pennypacker, H.S. (2009). *Strategies and Tactics of Behavioral Research*. Third Edition. New York: Routledge.

Jones S., Cooper, S.A., Smiley E., Allan L, Williamson A, Morrison J. (2008). Prevalence of, and factors associated with, problem behaviour in adults with intellectual disabilities. *Journal of Nervous and Mental Disease*, 196 (9), 678-86.

Kaptein, S., Jansen, D. E. M. C., Vogels, A. G. C., & Reijneveld, S.A. (2008). Mental health problems in children with intellectual disability: Use of the Strengths and Difficulties Questionnaire. *Journal of Intellectual Disability Research*, 52, 125–131.

Keenan, M. & Dillenburger, K. (2000). Images of Behavior Analysis: The Shaping Game and the behavioural stream. *Behavior and Social Issues*, 10, 19-38.

Little, J-A. & Saunders, K. (2015). A lack of vision: evidence for poor communication of visual problems and support needs in education statements/plans for children with SEN. *Public Health*, 129 (2), 143-8.

Martin, P. & Bateson, P. (2007). *Measuring Behaviour*. Third Edition. Cambridge: Cambridge University Press.

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, *67*(3), 267–77. http://doi.org/10.1016/j.jclinepi.2013.08.015

Miles, M. & Huberman, M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* Thousand Oaks CA: Sage.

Morale,S.E., Hughbanks-Wheaton, D.K., Cheng, C., Submaranian, V., O'Connor, A.R. & Birch, E.E. (2012). Visual Acuity Assessment of Children with Special Needs. *American Orthoptic Journal, 62* (1), p.90-98. DOI: 10.3368/aoj.62.1.90

Muris, P., Meesters, C. & van den Burg, F. (2003). The Strengths and Difficulties Questionnaire (SDQ): Further evidence for its reliability and validity in a community sample of Dutch children and adolescents. *European Child & Adolescent Psychiatry* 12, 1–8.

Nandakumar, K. & Leat, S. (2010). Bifocals in children with Down syndrome (BiDS) – visual acuity, accommodation and early literacy skills. *Acta Opthalmologica* 88, e196-e204.

Nock, M.K. & Kurtz, S.M.S. (2005). Direct Behavioral Observation in School Settings: Bringing Science to Practice. *Cognitive and Behavioral Practice* 12, 359–370,

Pilling, R. (2011). *The management of visual problems in adult patients who have learning disabilities*: The Royal College of Ophthalmologists. Available from https://www.rcophth.ac.uk/wp-content/uploads/2014/12/2011_PROF_128_The-management-of-visual-problems-in-people-with-learning-disabilities.pdf

Robson, C. & McCartan, K. (2016). *Real World Research* (4th ed). Chichester: Wiley

Roe, J. (2012). Social inclusion: meeting the socio-emotional needs of children with vision needs. *British Journal of Visual Impairment* 26 (2), 147-158.

Rothenberger, A., Becker, A., Erhart, M., Wille, N., Ravens-Sieberer, U. & the BELLA study group (2008). Psychometric properties of the parent strengths and difficulties questionnaire in the general population of German children and adolescents: results of the BELLA study. *European Child and Adolescent Psychiatry* [Suppl 1],17, 99–105

Salt, A. and Sargent, J. (2014). Common visual problems in children with disability. *Archives of Disease in Childhood* 99, 1163-1168.

Salleh, M.N., & Ali, M.M. (2010). Students with visual impairments and additional disabilities. *Procedia - Social and Behavioral Sciences* 7 (C), 717-719.

Strength and Difficulties Questionnaire (SDQ; 2001). SDQ: Normative School-Age SDQ Data from Britain. Retrieved March 29, 2019, from https://www.sdqinfo.org/norms/UKSchoolNorm.html

Stone, L.L., Otten, R., Engels R.C.M.E., Vermulst, A.A. & Janssens, J.M.A.M. (2010). Psychometric Properties of the Parent and Teacher Versions of the Strengths and Difficulties Questionnaire for 4- to 12-Year-Olds: A Review. *Clinical Child and Family Psychology Review* 13, 254–274.

Vernon, P. E. (2006). *Graded Word Spelling Test*. London: Hodder and Stoughton.

Vincent, D. & Crumpler, M. (2000). *Numeracy Progress Tests, Stage One Manual*. London: Hodder Education.

Wolpert, M., Gorzig, A., Deighton, J., Fugard, A.J.B., Newman, R. & Ford, T. (2015). *Child and Adolescent Mental Health* 20 (2), 94–101.

Woodhouse J. M., Davies, N., McAvinchey, A. & Ryan, B. (2014). Ocular and visual status among children in special schools in Wales: the burden of unrecognised visual impairment. *Archives of Disease in Childhood* 99, 500-504.

Wyers, J. (2018). Personal communication (December, 20).

Robson, C. & McCartan, K. (2016). *Real World Research.* Chichester*:* Wiley

Young, D. (1996). *Group Mathematics Test Manual*. London: Hodder Murray.

Accessible Summary

- Children with learning disabilities often have problems with their eye-sight.
- We tested the eyes of nine children and checked if they needed glasses or bigger print.
- We found that when they got what they needed to see better, their behaviour improved.
- This is important because children with learning disabilities need to be able to see as well as anyone else.

Table 1: Participants' details

Name*	Age	Diagnosis (EHCP); parent description	Vision assessment outcome	Recommendations /adjustments required to meet visual needs
Luke	4y 5 m	MLD, autism, SL and global developmental delay .	Luke was significantly hyperopic (R: +6.00/-0.50 x 90, L: +6.50DS). He had previously been given spectacles, but did not wear them. Without spectacles Luke had an accommodative deficit which reduced his visual performance. Luke exhibited evidence of cerebral visual processing impairment in relation to reduced performance with crowded/cluttered visual information (corrected binocular crowded LEA symbol acuity 0.4logMAR; single LEA symbol acuity 0.1logMAR). UNMET VISUAL NEED: uncorrected refractive error and cerebral visual impairment (CVI)	Parents and teachers were advised on the importance of full-time spectacle wear for Luke and were issued with strategies to encourage him to wear his spectacles. *Classroom intervention*: Spectacles should be worn at all times. Reduce clutter in environment and educational material. Ensure non-essential items are removed from desktop and school work presented in a simple, uncrowded format.
Áine	9y 8m	SLD, epilepsy, ADHD, Asperger's syndrome	Áine was significantly hyperopic (R: +4.50DS, L: +3.75DS) and wore spectacles full-time. Even with her spectacles in place, Aine's nystagmus caused her distance and near vision to be reduced compared to her peers (binocular distance crowded LEA symbol acuity 0.225logMAR [distance], 0.3logMAR [near]). UNMET VISUAL NEED: reduced vision at distance and near	*Classroom intervention:* Aine should be seated at the front of the class for whiteboard work. School/homework should be enlarged, bold and spaced out. Teaching staff were given examples of the size of print/pictures that Áine can see easily and which should be used for her educational and recreational materials.
Ciara	10y 2m	MLD/SLD, SL, OMCS - cyst on right hemisphere.	Ciara had good vision at both distance and near and did not need spectacles. Ciara had evidence of cerebral visual impairment; she had difficulties negotiating uneven ground and tripped at kerbs and over low furniture. She found crowded areas and cluttered visual information challenging. UNMET NEED: cerebral visual impairment	*Classroom intervention*: Ciara should sit at the front of the class where there are fewer visual distractions from other classmates. Reduce clutter in environment and educational material. Ensure non-essential items were removed from desktop and school work was presented in a simple, uncrowded format.
Shane	10y 4m	Cerebral palsy, quadriplegia, polymicrogyria, epilepsy	Shane was hyperopic and had astigmatism (R: +3.00/-1.00x165 L: +3.50/1.50x160). He had never worn spectacles and without spectacles his focusing was inaccurate and his distance and near vision were reduced (binocular crowded LEA symbol acuity 0.3logMAR [distance], 0.5logMAR [near]). Shane had a restricted visual field; he did not see objects that were positioned peripherally. Shane had evidence of cerebral visual impairment; his visual performance was poorer when visual information was cluttered and he took a long time to engage with visual information. UNMET NEED: uncorrected refractive error, visual field restriction, cerebral visual impairment.	Spectacles were dispensed to Shane. Parents and teachers were advised on the importance of full-time spectacle wear and strategies were issued to advise his carers on how best to encourage spectacle wear. *Classroom intervention*: Spectacles should be worn at all times. Shane should be seated directly in front of the whiteboard. Place educational and play material directly in front of Shane to allow him to engage with it more easily. Present schoolwork in a clear and uncluttered format, using simple pictures and words. Give extra time to visually process and engage with tasks. Appreciate that Shane is likely to become tired and fatigued quickly when doing school work due to his visual processing difficulties.
Rose	10y 5m	MLD	Rose was significantly hyperopic (R: +4.50/-3.25x175, L: +4.25/-3.25x170) and wears her spectacles full-time. With her spectacles on, she had good vision for both distant and near objects. Rose had evidence of cerebral visual processing difficulties; she had difficulties negotiating uneven ground, walking down stairs and bumping into low furniture. She found crowded areas and cluttered visual information challenging. UNMET NEED: cerebral visual impairment	*Classroom intervention*: Rose should sit at the front of the class where there are fewer visual distractions from other classmates. Reduce clutter in environment and educational material. Ensure non-essential items were removed from desktop and school work was presented in a simple, uncrowded format. Give verbal information to encourage increased awareness of obstacles when moving about.
Alan	11y 8m	MLD, Asperger's syndrome, ADHD, SL	Alan was hyperopic, anisometropic and astigmatic (R: +4.75/-1.25x180 L: +1.00DS) but had no spectacles to correct this refractive error. Alan's ability to see low contrast objects was significantly reduced for his age.	Spectacles were dispensed and full-time wear was advised. Parents and teachers were advised on the importance of full-time spectacle wear and strategies were issued to advise his carers on how best to encourage spectacle wear.

			Alan had evidence of cerebral visual processing difficulties; his behaviour deteriorated in crowded and busy environments, he was easily distracted and trips over edges of pavements and other low obstacles. UNMET NEED: uncorrected refractive error, reduced contrast sensitivity, cerebral visual impairment.	*Classroom intervention*: Spectacles should be worn at all times. Alan should sit at the front of the class where there are fewer visual distractions from other classmates. Reduce clutter in environment and educational material. Ensure non-essential items are removed from desktop and school work is presented in a simple, uncrowded format. Provide high contrast (e.g. black text on white, thick dark marker pen rather than pencil to write) reading and writing materials. Give verbal information to encourage increased awareness of obstacles when moving about.
Billy	4y 11m	MLD/SLD, autism, SL, SEBD	Billy had good visual function in all domains.	No adjustments required
Timothy	9y 11m	MLD, SEBD, autism	Timothy had good visual function in all domains.	No adjustments required
Conall	11y 6m	MLD	Conall had good visual function in all domains.	No adjustments required

*not their real name

Abbreviations: EHCP=Education Health and Care Plan ASD=Autism Spectrum Disorder; CP=Cerebral palsy; SEBD=Social, Emotional and Behavioural Disorder; MLD=Moderate Learning Disability; OMCS=Other Medical Conditions (not specified); PHYS=Physical disabilities; SL=Speech and Language difficulties; SLD=Severe Learning Disabilities; SENS=Special Educational Needs Statement, equivalent to Education, Health and Care Plan.

Table 2: Frequency of initiating engagement with peer/teacher*

Name	Obs.1	Obs.2	Obs.3	Obs.4	Obs.5	Obs.6	Obs.7	Obs.8	Average Obs 2 - 8
Luke	6	0	0	1	0	0	0	0	0
Áine	2	4	7	3	6	5	4	2	4.4
Ciara	1	0	3	10	4	1	6	3	3.8
Shane	3	1	4	2	2	2	11	2	3.4
Rose	2	3	4	7	2	5	4	3	4.0
Alan	1	7	0	5	2	6	8	0	4.0
Average	2.5								3.3
Billy	0	4	1	0	0	0	1	1	1.0
Timothy	9	13	13	5	8	5	5	5	7.7
Conall	3	9	4	4	2	8	1	0	4.0
Average	4.0								4.2

* Obs.1=baseline observation; Obs.2-8= post-intervention observations

Table 3: Frequency of off-task behaviour

Name	Obs.1	Obs.2	Obs.3	Obs.4	Obs.5	Obs.6	Obs.7	Obs.8	Average Obs 2 - 8
Luke	0	2	0	0	0	0	2	2	1.0
Áine	3	0	2	2	5	0	0	2	1.8
Ciara	1	0	1	1	1	0	1	1	0.8
Shane	0	3	0	0	0	0	0	0	0.5
Rose	0	0	0	2	0	0	0	0	0.3
Alan	4	2	0	0	2	4	1	1	1.6
Average	1.3								0.9
Billy	3	0	5	3	0	0	1	0	1.5
Timothy	4	3	7	6	7	6	5	3	5.3
Conall	2	0	2	2	8	0	5	0	2.4
Average	3.0								3.0

* Obs.1=baseline observation; Obs.2-8= post-intervention observations

Table 4: Frequency of positive teacher comments

Name	Obs.1	Obs.2	Obs.3	Obs.4	Obs.5	Obs.6	Obs.7	Obs.8	Average Obs 2 - 8
Luke	2	8	13	9	9	11	5	2	8.1
Áine	0	0	2	1	0	3	0	0	0.9
Ciara	2	0	6	0	0	0	0	0	0.9
Shane	0	0	0	1	0	0	0	0	0.1
Rose	1	1	0	0	0	0	1	0	0.3
Alan	3	2	1	4	0	7	1	7	3.1
Average	1.3								2.2
Billy	0	4	6	3	9	11	7	7	6.7
Timothy	0	0	1	0	0	4	0	1	0.9
Conall	3	1	2	0	2	5	5	2	2.4
Average	1.0								3.3

* Obs.1=baseline observation; Obs.2-8= post-intervention observations

Table 5: Frequency of repetitive behaviours

Name	Obs.1	Obs.2	Obs.3	Obs.4	Obs.5	Obs.6	Obs.7	Obs.8	Average Obs 2 - 8
Luke	0	0	0	0	0	0	2	0	0.3
Áine	0	10	0	0	0	0	0	0	1.4
Ciara	2	0	8	9	9	10	10	10	8.0
Shane	2	2	0	3	0	0	0	0	0.7
Rose	0	0	0	0	0	0	0	0	0
Alan	0	0	2	5	2	0	3	0	1.7
Average	0.7								2.0
Billy	0	0	8	0	0	0	0	2	1.4
Timothy	0	0	0	0	0	0	0	0	0
Conall	0	0	0	0	0	0	0	0	0
Average	0								0.5

* Obs.1=baseline observation; Obs.2-8=post-intervention observations. Events recorded in red: subsequent to completion, it was revealed that both children had neurological conditions which could result in repetitive movements.

Table 6: Academic attainment scores

			Spelling		**Maths**	
Name	**School year**	**Chronological age in years**	**Test age in years**	**Deficit years**	**Test age in years**	**Deficit years**
Áine	2017/2018	9.67	-	-	6.33	3.34
Ciara	2015/2016	8.00	-	-	5.08	2.92
	2017/2018	10.08	-	-	7.08	3.00
Rose	2017/2018	10.33	-	-	5.92	4.41
	2018/2019	11.33	7.50	3.83	8.08	3.25
Alan	2017/2018	11.57	10.00	1.58	6.92	4.75
	2018/2019	12.58	10.00	2.58	6.25	6.33
Timothy	2015/2016	8.17	6.83	1.34	6.58	1.59
	2016/2017	8.83	6.50	2.33	7.33	1.50
	2017/2018	9.92	8.00	1.92	6.58	3.34
	2018/2019	10.92	7.66	3.26	7.83	3.09
Conall	2017/2018	11.42	-	-	4.00	7.42
	2018/2019	12.42	5.33	7.09	7.58	4.84

Figure 1: Parent and teacher SDQ scores for each child pre- and post-assessment of visual needs, compared to British norm data