



## Using coloured filters to reduce the symptoms of visual stress in children with reading delay.

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3 Using coloured filters to reduce the symptoms of visual stress in children with reading  
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10 **Abstract**

11 Introduction: Meares Irlen Syndrome (MIS), otherwise known as ‘visual stress’, is  
12 one condition that can cause difficulties with reading. Aim: We aimed to compare the  
13 effect of two coloured filter systems on the symptoms of visual stress in children with  
14 reading delay. Materials and Methods: The study design was a pre--test, post--test,  
15 randomised head to head comparison of two filter systems on the symptoms of visual  
16 stress in school children. Sixty--eight UK mainstream school children with significant  
17 impairment in reading ability completed the study. Results: The filter systems  
18 appeared to have a large effect on the reported symptoms between pre and post three--  
19 month time points ( $d=2.5$ ,  $r=0.78$ ). Both filter types appeared to have large effects  
20 (Harris  $d=1.79$ ,  $r=0.69$  & DRT  $d=3.22$ ,  $r=0.85$ ). Importantly 35% of participants’  
21 symptoms reported that their symptoms had resolved completely. 72% of the 68  
22 children appeared to gain improvements in three or more visual stress  
23 symptoms. Conclusion and Significance: The reduction in symptoms, which appeared  
24 to be brought about by the use of coloured filters, eased the visual discomfort  
25 experienced by these children when reading. This type of intervention therefore has  
26 the potential to facilitate occupational engagement.  
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48 Key words: colour, early literacy, intervention, Meares--Irlen Syndrome, MISViS,  
49 occupational therapy, reading.

50 Type of manuscript-- original article-- full length research report.  
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## Introduction

Meares Irlen Syndrome (MIS), otherwise known as 'visual stress', occurs in 5 – 20% of the population<sup>(1)</sup>; it is thought to be one of the key visual causes of reading difficulties. Symptoms include letters appearing to blur, move around or go double, glare and headaches<sup>(2)</sup>. The aetiology of these is a contested topic and has been extensively discussed elsewhere<sup>(3)</sup>. Some people find coloured filters help to reduce or stop the symptoms, either when used as overlays on text or when used in spectacles; this type of intervention has been found to ease the discomfort experienced and to improve reading accuracy<sup>(4,5)</sup>.

Health conditions that limit occupational engagement can lead to occupational deprivation<sup>(6)</sup>; such deprivation reduces the learning opportunities essential for child development and quality of life. As such, facilitating engagement in reading is within the domain of occupational therapy; interventions and assistive technologies that support reading need to be tested to examine their efficacy for inclusion in occupational therapy practice.

The Occupational Therapy Practice Framework<sup>(7)</sup> highlights how essential reading is to participation in a range of daily living activities: preparing and reading shopping lists and selecting appropriate items when shopping, reading religious texts to undertake religious observance, accessing public transport through written timetables to allow for community mobility, all rely on reading performance. For children, participating in play, reading school books and reading prior to bedtime (sleep preparation), are also heavily dependent on the ability to read<sup>(7)</sup>.

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3 Reading is needed in work activities, managing finances and managing medication<sup>(7)</sup>.

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5 It is therefore important that professionals intervene to remediate reading difficulties  
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7 in order to prevent occupational performance problems in adulthood.  
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11 Failure to master basic literacy skills in the primary school years has been estimated  
12 to cost the UK tax payer between £5,000 and £43,000 per individual to the age of  
13 37<sup>(8)</sup>. If the filters allow a substantial number of children to read without the  
14 symptoms of visual stress, there would be clinical, educational and cost benefits.  
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21 Coloured filters can be used in spectacles. These have been developed by  
22 educationalists and researchers such as Irlen, Wilkins, Fowler, Harris and Stein. In  
23 this form they have more far reaching applications; they can filter light during both  
24 reading and writing tasks, on paper, computer screens or white boards. There has been  
25 one preliminary occupational therapy research study investigating the effects of  
26 coloured filters on occupational performance; however this was specific to children  
27 with a dual disorder of developmental coordination disorder (DCD) and visual stress.  
28 It was found that the coloured filters improved occupational performance in 5 out of  
29 the 6 participants suggesting the potential value of this type of assistive equipment in  
30 supporting occupational engagement<sup>(9)</sup>. Randomised controlled trials, examining the  
31 efficacy of coloured filtered lenses, commenced in the early 1990s. Beneficial effects  
32 were demonstrated through a range of outcomes; reductions in visual stress symptoms  
33 including eyestrain and headache<sup>(10)</sup>; improved reading accuracy and  
34 comprehension<sup>(4)</sup>; improved reading speed<sup>(11)</sup> and improved reading ability, motion  
35 sensitivity, convergence and accommodation control<sup>(12)</sup>. Sustained voluntary use of  
36 coloured filter lenses was found to be almost at the 80% level, demonstrating that the  
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3 individuals experienced continued benefits<sup>(13,14)</sup>.  
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7 Some studies have not found beneficial effects for example Menacker et al<sup>(15)</sup> failed  
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9 to show any effect of coloured glasses on reading, but it appears that they did not use  
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11 the full range of colours that the manufacturers require; thus their study protocol may  
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13 have limited any potential benefits of that particular lens system. In addition,  
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15 Menacker et al. <sup>(15)</sup> used inappropriate selection criteria as they chose to study people  
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17 with dyslexia, not people with visual stress. Since not all people with dyslexia have a  
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19 significant degree of visual stress<sup>(16)</sup>, then it is likely that only some of Menacker et  
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21 al's participants had visual stress; it is not surprising therefore that they did not find a  
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23 significant effect.  
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29 The UK College of Optometrists, which aims to provide a balanced view of the  
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31 evidence on the topic, supports the use of individually prescribed coloured filters to  
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33 ameliorate the symptoms of visual stress<sup>(17)</sup>. Visual stress can be part of a dyslexic  
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35 profile or stand--alone as a condition in its own right<sup>(16)</sup>. Interestingly, for people with  
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37 dyslexia, the American Pediatrics Association does not advocate the use of colour;  
38  
39 they state conclusively that reading difficulties are not caused by visual perceptual  
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41 deficits and have recommended that coloured filters are not offered in practice<sup>(18)</sup>.  
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43 Provision of coloured filters to reduce symptoms of visual stress clearly remains a  
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45 contentious issue.  
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51 As the use of coloured filters for treating the symptoms of visual stress is disputed,  
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53 further research is needed to test the efficacy of this intervention. Here we present a  
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55 trial to examine the effect of two coloured filters systems on the symptoms of visual  
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3 stress in children with reading delay.  
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## 7 **Materials and Methods**

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9 The study design was a pre-test, post-test, randomised head to head comparison of  
10 two coloured filter systems (Harris Foundation <sup>(19)</sup> and Dyslexia Research Trust <sup>(20)</sup>  
11 (DRT) systems) on the symptoms of visual stress in primary school children. These  
12 two systems were selected as the Local Education Authority requested that two filter  
13 systems with relatively simple screening procedures were tested. It was felt ethically  
14 unjustified to use a control group in the design as no benefit had been achieved with  
15 placebo filters during independent trials of these types of filters<sup>(21,22)</sup>. Ethics approval  
16 was gained from Oxford Research Ethics Committee (01.02) by JS. The full study  
17 design has been reported elsewhere as the data was collected as part of a trial which  
18 examined the effect of the filter systems on reading and spelling ability<sup>(22)</sup>. The effect  
19 of the two colour filter systems on the symptoms of visual stress is reported here.  
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### 36 *Participants*

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38 Mainstream school children with a significant impairment in reading capacity, defined  
39 as at least 18 months behind that expected for their age, were included for the study.  
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41 The 18 month reading lag was selected by the research team as it represented a  
42 sufficiently large delay to indicate reading difficulties but still remained within the  
43 realms of a child's normal academic ability. Children were required to be between the  
44 ages of seven and ten; they needed to be old enough to manage to wear spectacles but  
45 young enough to be learning to read. The Head of Special Educational Needs of ne  
46 Local Education Authority in England identified 87 children fulfilling the inclusion  
47 criteria using records held on their own database.  
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### *Recruitment*

The Local Education Authority gave permission for primary schools to recruit the identified sample. Following Head teacher's permission, the parents of these children were invited to give written informed consent for their child to join the study. All 87 initially consented, but one parent later withdrew consent leaving a total of 86 participants for the study.

### *Procedure*

#### *Baseline testing*

Baseline testing of the both visual and psychometric measures was conducted by one of the research team (RH). He had been trained by an orthoptist and a psychologist to undertake these respective tests. The children's visual capacity were tested eg convergence, accommodation and visual acuity and where there were any concerns they were referred to an optometrist to remedy any defects before being included in the trial. The British Abilities Scales (BAS II) subtests of similarities, matrices, recall of digits, reading and spelling were used to test general academic ability and literacy. Age was the final baseline variable collected. The general academic capacity of the children was found to be within normal limits, but as expected their reading and spelling were much worse, being 1.3 SD behind the population mean (10<sup>th</sup> percentile).

#### *Dependent variables*

The dependent variables measured were the number and type of visual stress symptoms experienced by the children; the symptoms were measured for each child before and after wearing the filters for at least 30 minutes a day over a three month

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3 period. A list of common symptoms, which had been agreed by a group of education  
4 and health experts with extensive research experience of visual stress were used to  
5 measure the symptoms experienced; a slightly condensed free version of this  
6 questionnaire has been recently published on line<sup>(23)</sup>. The nature of the questions were  
7 similar to those included in other published validated questionnaires<sup>(24,25)</sup>, but they  
8 differed in that they provided a shortened, simplified version, which was felt to be  
9 more suitable for use with young children. Pre--intervention and post--intervention  
10 the questionnaire was used with participants; they were individually asked if they  
11 experienced any of the symptoms when reading (see Table 1). They were asked to  
12 answer yes or no to each question. Words like halo, aura, & glare were discussed to  
13 ensure the child understood the questions. The rationale for asking the child about  
14 the presence of MIS symptoms is to identify if they experience these symptoms;  
15 these symptoms would interfere with their ability to see the letters clearly and to  
16 be able to track their eyes along the line of letters. Children with reading  
17 difficulties are likely to develop delays in their reading ability.

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43 The scores were used to determine if there had been a statistically significant effect of  
44 intervention on type and number of symptoms across time points and across type of  
45 filter.  
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52 *Intervention procedure*

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54 *Random allocation of filter systems to schools*  
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3 An independent researcher, using a table of random numbers, assigned the Harris  
4 filters to one of two groups of schools, selected to be of equivalent socio--economic  
5 status. DRT filters were assigned to the other group. Allocation to group produced 42  
6 participants for the Dyslexia Research Trust filters and 44 participants for the Harris  
7 filters; the allocations were held in sealed envelopes, which were not opened until  
8 after baseline testing had occurred. Once baseline tests had been carried out, children  
9 were offered the filter system assigned to that school. At baseline there were no  
10 statistical differences between groups according to filter type allocated.  
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### 23 *Selection of filter colour for individual children*

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25 The children went through either the Harris Foundation or Dyslexia Research Trust  
26 procedure for selecting the appropriate individualised colours. The methods used to  
27 select the filters followed the protocols prescribed by the filter designers: the  
28 researcher (RH) had been trained by the two filter companies to determine optimal  
29 selection of the coloured filter for the child and undertook the selection process with  
30 the children. With regard to choice of colours, DRT offers two sets of spectacles; one  
31 with 2 blue lenses; the other with 2 yellow lenses. Harris Foundation, offers a larger  
32 number of colours and tests a different tint for each eye. The Harris Foundation  
33 company keeps the number of colours and range of colours it uses confidential. DRT  
34 filters took less than five minutes to select per child and Harris filters took  
35 approximately 15--30 minutes.  
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### 52 *Pre--intervention procedure*

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54 A total of 86 participants' were surveyed for type and number of symptoms of visual  
55 stress at the pre--intervention stage. At baseline, out of the 11 surveyed symptoms of  
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3 visual stress, 86 of children interviewed experienced a mean of 5.3 symptoms (SD  
4 2.5), with a range of between 0--10 symptoms. Participants were then offered the  
5 filter to look through. Five of the DRT group and eight of the Harris group did not  
6 find the filters beneficial. Those 13 who did not feel the filters were helpful had a  
7 lower level of symptoms ( $m=3.46$ ,  $SD=1.94$ ) than those 73 who found the filters  
8 helpful ( $m=5.60$ ,  $SD=2.50$ ). This was a statistically significant difference ( $t=3.03$ ,  
9  $p=0.003$ ). The 73 (85%) children who said that the filters did make the letters look  
10 clearer, or stopped the letters moving, were asked to use the colour in spectacles for  
11 the next three months, for reading and writing work; 37 used DRT filters and 36 used  
12 Harris filters; in total 73 children received the intervention.

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Children were asked, by the teacher, to wear the filters for at least 30 minutes per day at school for reading activity, whether for book or whiteboard tasks. Compliance was ascertained through individual teacher report. Parents were not actively involved in the intervention. After three months the children were asked again about their symptoms using the questions in Table 1: this was undertaken by another researcher (NR) ~~if any of their symptoms had stopped or reduced~~. The children were told not to bring their filters with them or to share what type of filters they had used. NR was not given any of the baseline data or made aware of which filters the child had used.

Five participants were lost at the follow up stage; of the five, four participants were not available for retesting and one participant's data could not be recorded as they gave unclear answers: all five were in the Dyslexia Research Trust group. Those that dropped out at follow-up did not have a different number of symptoms than those who were followed up ( $t=0.56$ ,  $p=0.58$ ). Sixty eight participant data sets were

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3 included in analysis (DRT n=32, Harris n=36). Analysis was undertaken by PH. See  
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5 Figure 1.  
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10 Place Figure 1 about here.  
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## 12 13 14 **Results**

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16 *Type of symptoms experienced pre and post intervention.*

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18 Pre--intervention the frequency with which the different types of symptoms were  
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20 experienced was high (mean 35, sd 15.1, range 15 to 58, n=68) (see table 2). For  
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22 example: difficulty reading small print was experienced by 58 of the 68 participants.  
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24 The letters moving was the least experienced symptom, but it was still experienced by  
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27 15 of the participants.  
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36 Post--intervention, frequency of symptoms had reduced across all types experienced  
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38 (by mean 7.27, sd 3.97, range 2 to 15 -- see Figure 2). There was a significant  
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40 reduction in symptoms (mean 27.23) but the reduction was quite wide ranging (sd  
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42 12.2) with some symptoms reduced much more than others. Those that had reduced  
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44 the most were the ones that had been most frequent pre--intervention. The  
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46 intervention had a large effect on the symptoms of the group between pre and post  
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48 time points ( $d=2.5$ ,  $r=0.78$ ).  
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3 *Number of symptoms experienced pre and post intervention.*  
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5 On average, the pre-intervention symptoms of visual stress per child were  
6 significantly reduced; pre--intervention the individual mean number of symptoms per  
7 child was 5.65 (SD=2.5), post intervention the mean per child was 1.18 (SD=1.28).  
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9 Overall, it was found that there was a statistically significant reduction in the  
10 symptoms ( $t=13.34$ ,  $p<.001$ ) with the intervention having been found to produce a  
11 large effect ( $d=2.29$ ,  $r=0.75$ ).  
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21 The most common number of symptoms experienced was seven and the maximum  
22 number of symptoms experienced by an individual participant was 10 (see figure 3).  
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24 Post intervention the total number of symptoms experienced had dropped to 80, a  
25 drop of 80%. Importantly 24 (35%) participants' symptoms had resolved completely  
26 and in 24 participants their symptoms had reduced to only one type. 72% of the 68  
27 children gained improvements in three or more of the visual stress symptoms.  
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40 Both groups reported a large reduction in symptoms (Harris  $d=1.79$ ,  $r=0.69$  &  
41 DRT= $3.22$ ,  $r=0.85$ ) and this effect was significantly greater in the group with DRT  
42 filters ( $M=5.28$ ,  $SD= 2.10$ ) than the group with Harris filters.  
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49 Of those who received the DRT filters, 13 (40%) participants' symptoms had resolved  
50 completely and 10 (31%) reduced to only experiencing one symptom. The maximum  
51 number of symptoms dropped from 10 to 5 symptoms (see figure 4).  
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8 Of those who received the Harris filters, 11 (30%) participants' symptoms had  
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10 resolved completely and 14 (39%) reduced to only experiencing one symptom. The  
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12 maximum number of symptoms dropped from 10 to 6 symptoms with all but one  
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14 experiencing three symptoms or less (see figure 5).  
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18 For those using the Harris filters, on average, the symptoms of visual stress were  
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20 reduced (n=36); pre--intervention the mean number of symptoms was 4.49 (SD=2.67)  
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22 and post intervention their mean number of symptoms was 1.19 (SD=1.24).  
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### 31 32 **Discussion** 33 34 35 36 37

38 The children experienced high rates of the symptoms characteristic of visual stress;.  
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40 Symptoms that were experienced included font moving, blurring, glare, double vision  
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42 and headaches as identified by Stein and Fowler<sup>(2)</sup> as well as eyestrain and headache  
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44 as identified by Wilkins<sup>(10)</sup>. For children experiencing headaches, who also have a  
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46 reading delay, visual stress needs to be considered by clinicians as a possible cause of  
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48 their symptoms. For intelligent children the reading delay maybe less apparent and so  
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50 headaches are more indicative of possible visual stress.  
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54 Of children who chose not to try filters, or said they did not help, half had 5 or 6  
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56 symptoms and half had 2 symptoms or less. Interestingly, none of the 10 said the font  
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3 moved; it maybe this is a particularly disabling symptom and unless it is present the  
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5 child does not wish to wear the filters. Some children may not have wished to wear  
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7 the filters due to perceived social stigma.  
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11 There is no cut off score for visual stress symptom at present. A cut off score is not  
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13 sought as it is recognised that the symptoms are not equally weighted and the  
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15 symptoms may affect children in different ways- indeed the effect of one symptom  
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17 could be very disabling to an individual child. By avoiding a cut off score, it is  
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19 possible to ensure no symptomatic child is excluded from being offered a potentially  
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21 beneficial intervention.  
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27 The presence of visual stress symptoms appears high in children with reading delay. It  
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29 may be that some of these children have dyslexia but others may have different  
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31 conditions<sup>(13)</sup>. A large prevalence study of both selected and unselected samples,  
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33 would be useful to establish prevalence rates in the UK. Refinement of robust  
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35 measures for the symptoms of visual stress and further development of standardised  
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37 protocols for the administration of such tests could be published to assist parents,  
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39 teachers and other professionals to screen children for this condition and provide  
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41 outcome measures for testing interventions.  
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47 It is apparent that the filters reduced the number and range of the children's visual  
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49 stress symptoms, suggesting that coloured filters are helpful in treating this type of  
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51 condition. However when trying the filters, at the point of entry into the trial, 13  
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53 children did not feel they were beneficial and chose not to wear them. Thus coloured  
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55 filters may not be beneficial for all children experiencing visual stress symptoms.  
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3 Perhaps these were the children who were more highly represented in the studies of  
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5 Menaker et al. <sup>(15)</sup>, who did not report a positive effect of filter use.  
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10 We took a population of children with reading delay sufficient to recruit to a trial; of  
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12 those a large number experienced MIS symptoms. We have not undertaken a  
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14 prevalence study and so cannot make generalisations about symptom level in those  
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16 with reading delay or those in the general population. Our trial did not include a  
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18 control group; the rationale for this decision was presented in the methods however we  
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20 recognize this is a limitation of the study as had a control group been included,  
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22 concern related to any placebo effect could have been alleviated. We can discuss the  
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24 relative effect of the filters on children with reading delay, by comparing the effect of  
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26 two systems across pre and post intervention time points but not the absolute effect as  
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28 compared with a control group.  
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34 It is interesting to note that the beneficial effects of the coloured filters on visual stress  
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36 symptoms were mirrored by reading improvements, as measured by increases in BAS  
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38 s scores, in a parallel study in the same children<sup>(22)</sup>; after wearing either kind of filter  
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40 for 3 months both the DRT and the Harris Foundation groups had improved their  
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42 BAS s scores 1.8 and Harris by 1.7: equivalent to an average of 4.5 months over the 3  
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44 months, i.e. 1.5 months more than you would expect for an average child's progress.  
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46 The BAS scoring system accounts for maturation as it is based on normalised data;  
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48 this is recognised as a robust measure of reading ability. In addition the DRT filters,  
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50 which had a more beneficial effect on visual stress symptoms, were also found to  
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52 have had more effect on spelling ability and certain types of reading speed than those  
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54 of participants using the Harris system<sup>(22)</sup>.  
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5 Children in the trial had been receiving support from a Special Educational Needs Co-  
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7 -ordinator, due to their reading delay and yet they were still more than 18 months  
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9 behind with their reading. For 35% of the children in the trial, their symptoms were  
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11 completely resolved by wearing the filters. For these children it is apparent that filter  
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13 use was very beneficial.  
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18 The process needed to support such children with reading delay can depend on a  
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20 number of factors. Some governments have stopped automatic eye checks for children  
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22 starting school. This could be usefully reintroduced as visual problems maybe a  
23  
24 common the cause of illiteracy. We recommend that any child who is struggling to  
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26 learn to read should visit an optometrist as there maybe an underlying medical  
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28 condition which need addressing. If the eye itself is healthy then coloured filters could  
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30 be trialed to identify if this aids reading ability.  
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37 The different manufacturers have different processes for referral and provision. There  
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39 are a range of filter manufacturers who offer this type of service and their details can  
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41 be found on the World Wide Web<sup>(23)</sup>. Some, such as Cerium's Intuitive Colorimeter  
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43 lenses have to be prescribed by an optometrist. Health and educational professionals  
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45 can refer children to optometrists who advertise this type of service. The Irlen  
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47 Institute and Harris Foundation train their own assessors; training can be undertaken  
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49 by health or education professionals or referrals made to the trained assessors.  
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52 Screening tools and protocols for DRT lenses are freely available for use by  
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54 professionals and parents at a dedicated website

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56 [www.colouredlensesandvisualstress](http://www.colouredlensesandvisualstress)<sup>(23)</sup>; alternatively assessment can be arranged by  
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2  
3 booking through the DRT website services. The spectacles containing the DRT filters  
4  
5 have been distributed through primary schools by form teachers, occupational  
6  
7 therapists, SENCOs and Headteachers.  
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10  
11 Screening for the symptoms of visual stress and facilitation of the provision of filters  
12  
13 for those who find them beneficial could be a valuable collaborative opportunity for  
14  
15 teachers and occupational therapists to support children with reading difficulties. If  
16  
17 children are enabled to read text they can improve their reading performance. Reading  
18  
19 performance is essential for academic achievement in a range of subjects and can  
20  
21 therefore influence potential for academic achievement and future career choice.  
22  
23 Reading is also essential for a range of activities of daily living. In these ways  
24  
25 enabling children to be able to read can support occupational engagement in all three  
26  
27 domains of self care, work and leisure. Provision of coloured filters for these children  
28  
29 could be a clinically and educationally effective intervention.  
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Table 1 Survey questions

Do you:

Q1 have any difficulty seeing the words when you read?

Q2 get headaches or eye aches when you read?

Q3 lose your place on the page?

Q4 have particular problems with small, crowded print?

Q5 have 'double vision', i.e. letters and words splitting into two?

Q6 find the print becomes blurred or out of focus?  
see letters or words moving around on the page and board e.g.  
jumping, shaking, swimming?

Q8 see letters or words moving 'in and out' of the page?

Q9 have 'glare' or discomfort from reading in a bright light?

Q10 see a 'halo' or 'aura' around words?

Q11 have problems or discomfort reading from a computer screen

Table 2 Frequency of symptom type experienced (n68)

Symptom type	frequency pre-intervention	frequency post intervention	frequency reduction
Q7 font moving	15	2	13
Q11 comp. v book	16	9	7
Q8 in & out	21	3	18
Q10 halo	25	4	21
Q5 double vision	27	4	23
Q6 blurring	38	8	30
Q2 aches	39	8	31
Q1 difficulty	44	6	38
Q9 glare	45	9	36
Q3 lose place	56	12	44
Q4 small print	58	15	43
Total	384	80	304
mean	34.91	7.27	27.64
std dev.	15.16	3.98	12.23

Figure 1 CONSORT Flow Diagram

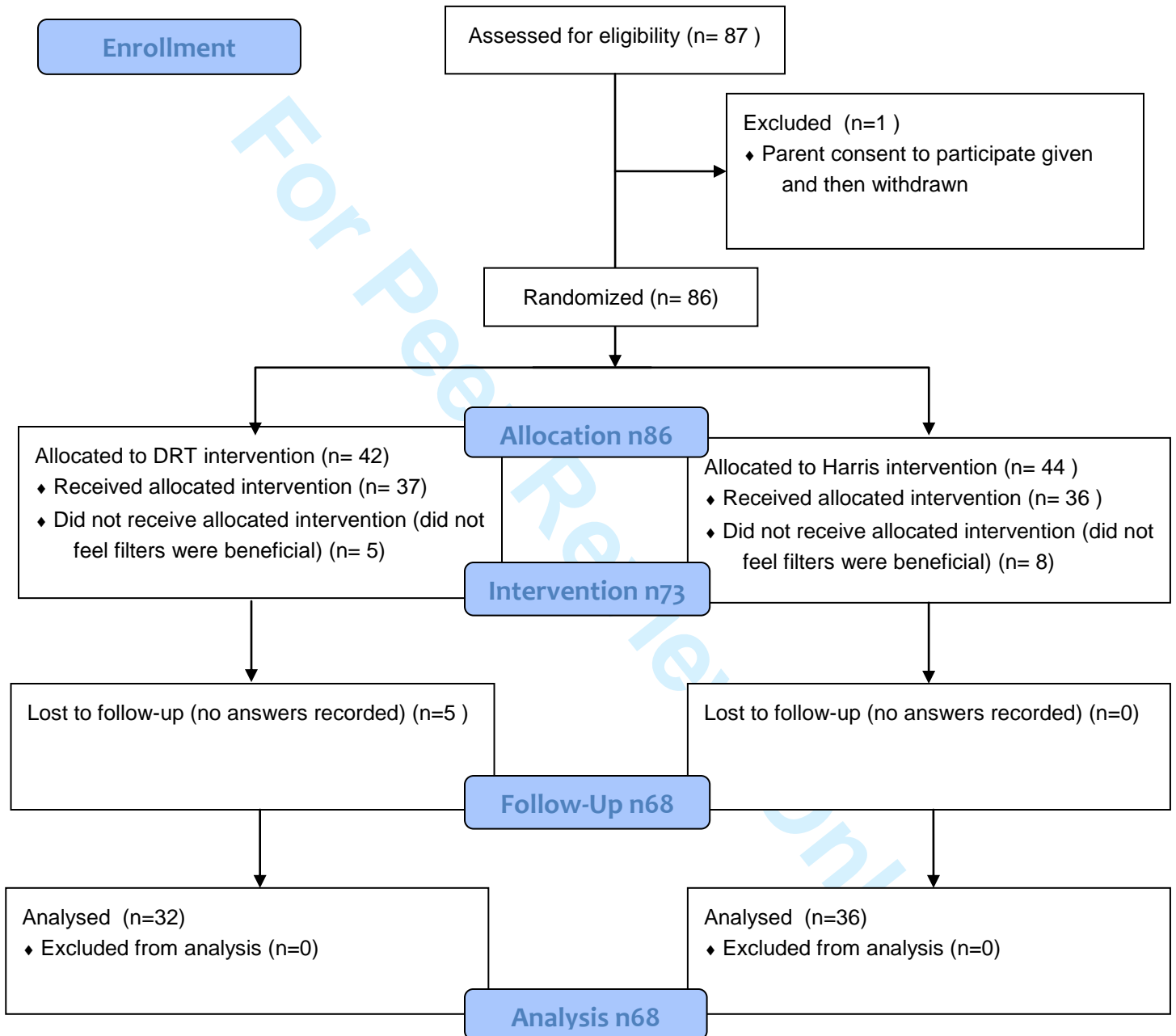


Figure 2 Type of symptoms experienced pre and post intervention (n68).

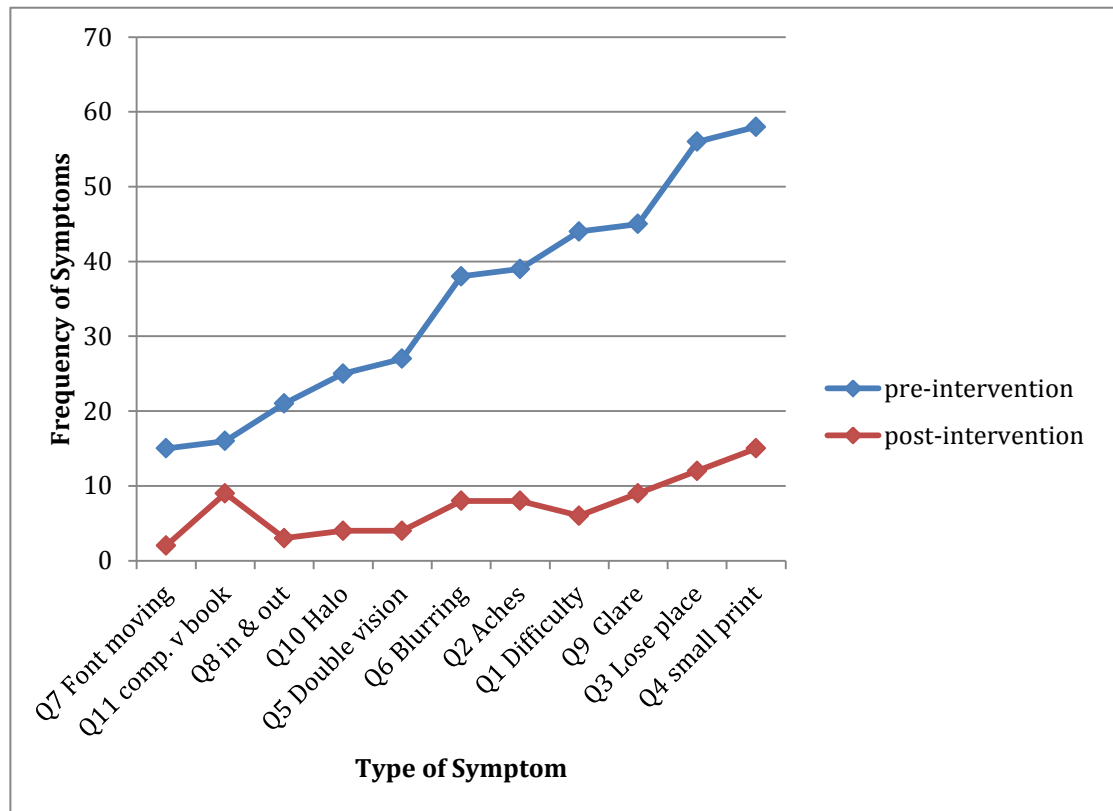


Figure 3 Number of children experiencing symptoms pre and post intervention (n68).

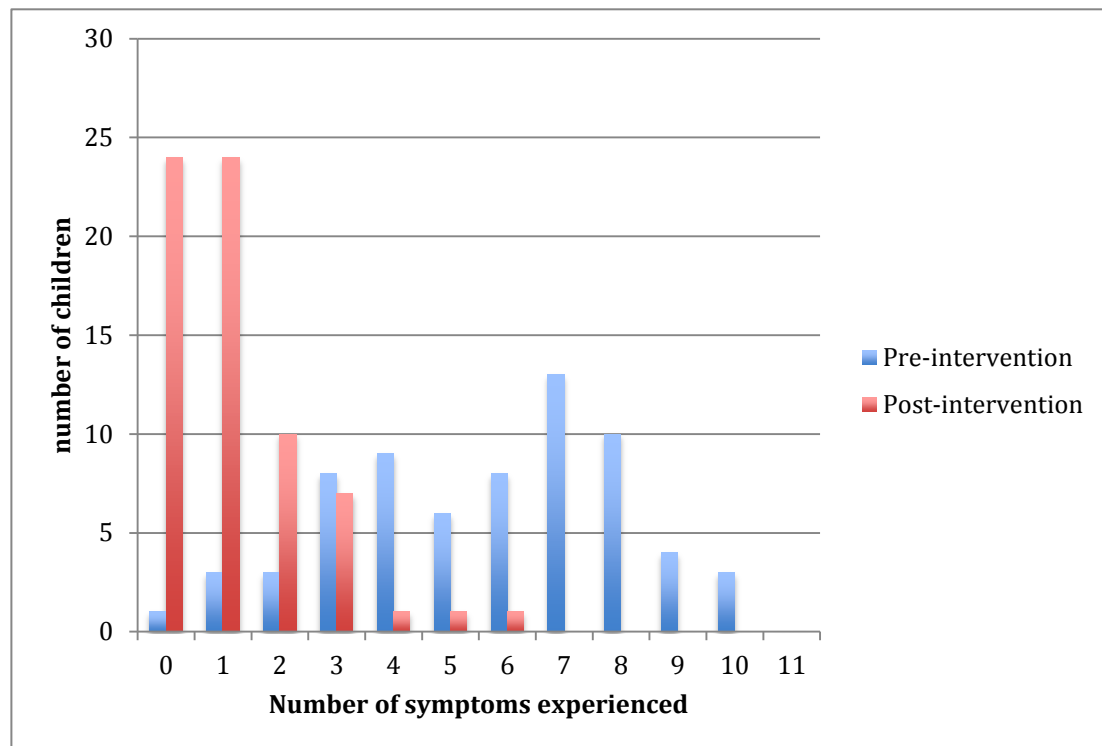
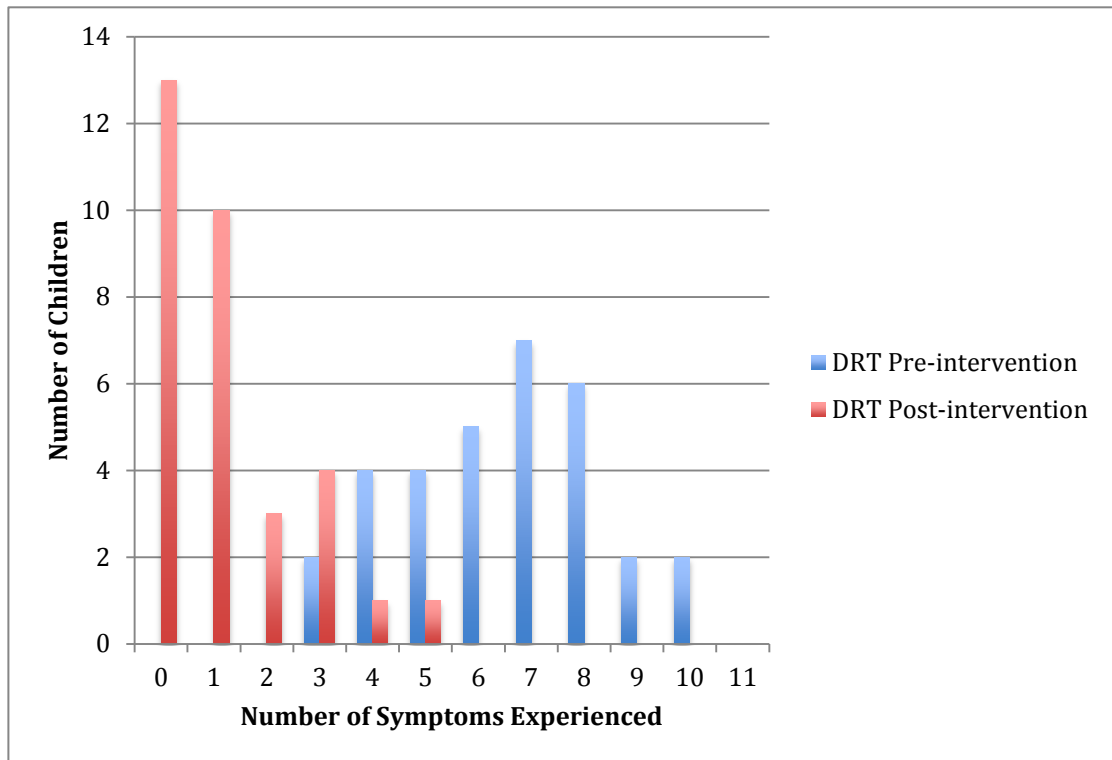


Figure 4 Number of symptoms experienced by participants using DRT filters pre and post intervention (n32).



Review Only



Figure 5 Number of symptoms experienced by participants using Harris filters pre and post intervention (n36).

