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Visual demands in modern Australian primary school classrooms.
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Title: Visual demands in modern Australian primary school classrooms

Running head: 'Visual demands in primary school'

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Background: The visual demands of modern classrooms are poorly understood yet are relevant in determining the levels of visual function required to perform optimally within this environment.

Methods: 'Thirty three' Year 5 and 6 classrooms from eight South East Queensland schools were included. Classroom activities undertaken during a full school day (9am-3pm) were observed and a range of measurements recorded, including classroom environment (physical dimensions, illumination levels), text size and contrast of learning materials, habitual working distances (distance and estimated for near) and time spent performing various classroom tasks. These measures were used to calculate demand-related minimum criteria for distance and near visual acuity, contrast and sustained use of accommodation and vergence.

Results: The visual acuity demands for distance and near were 0.33 ± 0.13 and 0.72 ± 0.09 logMAR respectively (using habitual viewing distances and smallest target sizes) or 0.33 ± 0.09 logMAR assuming a 2.5 times acuity reserve for sustained near tasks. The mean contrast levels of learning materials at distance and near were >70%. Near tasks (47%) dominated the academic tasks performed in the classroom followed by distance (29%), distance to near (15%) and computer-based (9%). On average, children engaged in continuous near fixation for 23 ± 5 minutes at a time and during distance-near tasks performed fixation changes 10 ± 1 times per minute. The mean estimated habitual near working distance was 23 ± 1 cm (4.38 ± 0.24 D accommodative demand) and the vergence demand was 0.86 ± 0.07Δ at distance and 21.94 ± 1.09Δ at near assuming an average pupillary distance of 56 mm.

Conclusions: Relatively high levels of visual acuity, contrast demand and sustained accommodative-convergence responses are required to meet the requirements of modern

classroom environments. These findings provide an evidence base to inform prescribing guidelines and develop paediatric vision screening protocols and referral criteria.

Visual anomalies which reduce the efficiency of the visual system may potentially reduce the capacity for children to perform optimally at school.[1] Thus, vision screening prior to or during the early school years is critical. However, there is a common misconception that distance visual acuity is the only measure of visual function relevant in the classroom environment and that habitual visual acuity measured with standard high contrast letter charts adequately represents the functioning of the entire visual system.[2-4] It is likely that a child's ability to perform efficiently in school depends upon a range of other visual factors such as contrast demand, eye movement control, focusing responses and binocular coordination,[5] which are not reflected by measures of distance visual acuity alone.

The nature of visual demands in school classrooms is likely to differ depending on the age of the child.[6,7] Two different stages of learning have been proposed: 'learning to read' for children in early primary school and 'reading to learn' for older children.[8,9] Only a limited number of studies have investigated the visual demands of primary school classrooms in this later stage where more sustained visual effort is required. An observational study in the USA (which included 11 classrooms from 4 schools) showed that children in Grades 4 and 5 (ages 9 to 11 years) spend about four to five hours daily on academic activities, with 54% of this time allocated to reading and writing tasks.[5] On average, students engaged in continuous near work tasks for 16 minutes at a time and sustained distance tasks for approximately 7 minutes at a time. However, this study was conducted over 20 years ago and is unlikely to fully reflect the current demands of modern school classrooms, which employ a range of technologies such as computers and smart boards.

More recently, Langford and Hug[10] examined visual acuity demands in a single USA primary school, from kindergarten to the fifth grade (children aged 5 to 11 years). Distance and near visual acuity demand increased with increasing grade level, with the distance acuity demand being always greater than near. This study, however, only assessed threshold acuity levels for a limited series of classroom tasks, while omitting the role of other important visual functions, such as contrast and accommodation-vergence demand, as well as oculomotor skills, which are widely considered to impact on learning in school.[5,11]

In addition to visual skills, other physical aspects of a classroom such as its size and lighting levels are believed to be important contributing factors to the learning process given that a conducive physical environment may be necessary for student comfort and ability to learn.[12] These physical factors also indirectly influence students' visual requirements such as visual acuity (classroom size) and the contrast of learning materials (illumination levels). However, existing recommendations for optimal classroom dimensions vary greatly between countries; 4.75m^2 per student in the USA[13] compared to 1.87m^2 to 2.33m^2 per student in the UK.[14] Similarly, standards regarding the minimum illumination levels in school classrooms also vary between countries, ranging from 240 to 500 lux.[15-17]

The visual demands placed on children need to be considered when determining appropriate prescribing guidelines for children with functional problems.[18] Currently, there are few evidence-based guidelines available regarding appropriate management strategies for common non-amblyogenic visual problems in children, such as low magnitude refractive error or non-strabismic binocular anomalies.[18,19] Some eye care practitioners suggest that refractive correction may not be critical in the early schooling years in the absence of any amblyogenic risk factors, even if uncorrected visual acuity is worse than 6/12 (0.30 logMAR).[20] Conversely, others recommend the correction of low magnitude refractive errors even when there is no significant reduction in visual acuity,[21,22] particularly with regard to functional performance of the visual system relating to how the two eyes are used together during academic related activities that a child is expected to undertake in the classroom, such as reading and writing. These differences in paediatric optometric management approaches may be partially attributed to the paucity of evidence regarding the actual visual demands of classrooms.

A recent review of paediatric vision screening guidelines further highlighted the lack of uniformly accepted protocols for childhood vision screening worldwide.[23] Opinions vary greatly regarding the most appropriate tests that should be included, the ideal age for screening, frequency of screening and most importantly, the referral criteria that should be adopted for further comprehensive vision examination.[24-26] This problem may also be related to the lack of evidence from well-designed studies regarding the levels of visual function required by school children.

The aim of this study was therefore to quantify the visual demands imposed upon children within modern Australian primary school classrooms, in order to determine the typical levels of visual function required by children to perform optimally within this environment.

METHODS

'Thirty three' Year 5 and 6 (children aged 10 to 12 years) classrooms from eight Queensland state primary schools were included. Primary schools were the focus of this study given that for children at this developmental stage, there is an emphasis on acquiring appropriate elementary learning skills to carry into their secondary education.[27] In addition, their sensory-motor visual skills are likely to have reached maturity by this age.[9] Approval from the Department of Education, Training and Employment (DETE) and the Queensland University of Technology (QUT) Research Ethics Committee was obtained prior to conducting the study.

Observation protocol

Learning activities in each classroom were observed for a single day and recorded from 9am to 3pm (normal schooling hours for Queensland state primary schools) by two observers. Classroom observations were scheduled on typical school days that were convenient for teachers and did not include tasks scheduled outside of ordinary classroom activities. The following measurements were undertaken in each of the classrooms:

(i) Classroom dimensions

The length and width of each classroom was recorded along with the maximum distance at which a child could be seated from the board. Three measurements were taken for each distance and averaged.

(ii) Illumination levels

Illumination levels were measured using a Topcon IM-20 illumination meter. Illumination levels varied within each classroom due to differences in the position of the light source or windows, which necessitated the requirement to obtain measurements at different locations within a single classroom. Therefore, each classroom was divided into five sectors as shown in Figure 1 based on a previous study.[5] The allocation of the sectors was consistent between rooms with sector 1 being the front section (where the white/smart board was located), followed by sector 2 at the front, right section. The order of the remaining sectors is presented in Figure 1. Three measures of illumination levels were obtained within a 20 minute time period in the middle of each of the sectors (at table/desk height), at three different time points; 9am, 12.30pm and 3pm.

Insert Figure 1 here

(iii) Visual acuity demands

The vertical dimension of the text contained within learning materials used in each classroom was measured (using a ruler) to determine the theoretical visual acuity required for resolution. The smallest vertical height of learning materials, which posed the greatest acuity demand, was further analysed to determine the visual acuity equivalents (in logMAR). The vertical heights of these targets and the maximum distance from which they were viewed were used to calculate the maximum distance acuity threshold demands within the various classrooms, as previously described by Langford and Hug.[10] The critical detail of the text examined was arbitrarily taken as 1/5th the letter height.[28] The same formula was used to calculate the mean estimated near visual acuity threshold demand, using a validated estimate of near working distance (to the nearest 5cm, see below) and the measured minimum target sizes presented for near tasks. The near working distance of randomly selected students were estimated by both observers (to the nearest 5cm) while the children were performing near work tasks in each of the observed classrooms. The actual near working distance of individual children was not measured due to ethics clearance restrictions that did not allow direct interaction with the children, and also to minimise disruption of classroom activities. In order to determine the accuracy of the two independent observer's estimation of near working distances, a separate pilot study was conducted. The first author and the four observers independently estimated the near working distances (to the nearest 5cm) of 15 adult participants reading a book while seated at a table. The estimated values were then compared to the actual near working distances (to the nearest 1 cm) recorded by an additional independent (fifth) observer using a measuring tape. The 95% limits of agreement (LoA) were; -2.93 cm to 3.89 cm (approximately 7 cm) for the first author and -3.50 cm to 3.90 cm (approximately 7 cm) for the four additional observers averaged together. The mean difference between the actual and estimated working distance was close to zero (less than 0.5 cm), indicating good agreement.[29] Given that an 'acuity reserve' of at least 2.5 times the threshold visual acuity has been shown to be required for comfortable sustained near tasks in children with normal vision,[30,31] the near threshold values were then converted to actual near visual acuity demands using this guideline.

(iv) Contrast levels

A photometer (Topcon Luminance Colorimeter BM7) was used to measure the luminance levels of various classroom learning materials (using a 0.1° field size). These values were then used to calculate the contrast demand based on Weber's formula (luminance contrast = $L_{background}$-L_{target}/$L_{background}$), which is typically used for non-periodic patterns such as letters on charts.[32] Luminance measurements were obtained within a 20 minute period at three time points during the day; 9am, 12.30pm and 3pm. Three separate measurements were acquired at each time point and averaged. Contrast reserves were calculated using the formula (contrast reserve = target contrast/contrast threshold)[33] based on contrast thresholds for visually normal children of 0.03 (0.3%) at a spatial frequency of 3 cycles per degree (a mid-spatial frequency and the approximate peak of the contrast sensitivity function) and a contrast threshold of 0.02 (2%) at spatial frequencies of 0.33 and 10 cycles per degree (lower and higher spatial frequencies corresponding with reduced contrast sensitivity relative to the contrast sensitivity function peak).[34]

(v) Classroom activities

Learning activities were observed over one entire school day (from 9am to 3pm) in each of the classrooms and recorded using a hard copy diary on a minute-by-minute basis. The observer sat in an unobtrusive location in the classroom and was not involved in any of the children's activities. The diary recordings were used to quantify the amount of time children spent performing specific academic-based tasks. Activities were then classified into the respective categories outlined below as suggested by Ritty et al.,[5] with the inclusion of an additional 'computer tasks' category:

a) Distance tasks – any activity that required students to sustain distance fixation without intermittent diversion to near material.

b) Near tasks – any near reading or writing based activities, not involving screen-based equipment.

c) Distance to near tasks – any activity which required the students to change fixation from distance to near and distance again such as repeated copying from the board.

d) Computer tasks – any activity which required the students to operate desktop computers or laptops.

e) General tasks – any non-academic activity such as break times and transition times between lessons.

The frequency of distance to near fixation changes performed by the children during one minute observation periods when learning tasks occurred, which required repeated changes in fixation from distance to near, such as copying from the board, was also recorded. This observation was carried out on approximately 35% of randomly selected children from each classroom (~10 students in each) and the mean number of fixation changes was calculated.

Since a number of parameters were determined through estimation or observation methods (due to ethics clearance restrictions which did not allow direct interaction with the children), a second trained observer was also present with the first author to simultaneously conduct the observation procedures to provide a second independent estimation of student near working distances, the number of fixation changes, as well as the coding of learning activities. The additional observer (one in each class) was present for an average of 2 hours (any time within the 9am to 3pm school hours). The mean differences in the estimation of near working distance (-0.07 ± 2.04 cm, LoA: 3.94 to -4.06) and fixation changes (-0.12 ± 0.56 fixation changes per minute, LoA: 0.98 to -1.22) approached zero, which shows good agreement between observers (Figures 2 and 3). The average Kappa statistics for coding of classroom learning activities was 0.88, which further demonstrates good agreement.[35] These results collectively indicated high levels of inter-observer agreement and reliability. The results reported in this manuscript are the average values for two of the independent observers.

Insert Figure 2 and 3 here

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS version 21.0. One way analysis of variance (ANOVA) was performed to evaluate the variation in each of the classroom measures between schools and repeated measures ANOVA were conducted to investigate changes in illumination and contrast levels throughout the day. Descriptive statistics are reported as the mean and standard deviation. P-values less than 0.05 were considered statistically significant.

RESULTS

Classroom dimensions

On average, classrooms were rectangular in shape (7.74 ± 0.79 m long x 6.97 ± 0.87 m wide). The spatial organisation of student's desks varied greatly between classrooms; however, all classrooms were equipped with a chalk board or white board, a smart board and computers. Windows were generally located on either one or both side walls, but there were large variations in their exact position in every classroom. Each classroom was occupied by an average of 27 ± 2 students (range: 22 to 30) and one teacher.

Illumination levels

Illumination levels for each sector over the course of the school day are summarised in Table 1. Illumination levels varied significantly with sector position ($p<0.001$) and time of day ($p<0.001$), with the lowest illumination levels observed in the front section of the classroom (S1) later in the day (3pm). However, the inter-school differences were not consistent between time points throughout the day or between classroom locations. Illumination levels varied greatly within each classroom at every measurement point, with some of these values falling below the minimum Australian Standards recommendation (240 lux). Throughout the day, the percentage of classrooms (considering all sectors) with illumination levels below 240 lux was consistent; 9am (7%), 12.30pm (8%) and 3pm (10%). However, examining each sector individually revealed that lighting levels in S1 were more often below the recommended level; S1 (25%), S2 (1%), S3 (8%), S4 (4%) and S5 (4%).

Insert Table 1 here

Visual acuity demand

Various types of learning materials were used in each classroom. The mean of the smallest target size, working distances and calculated visual acuity threshold and actual demands for all 33 classrooms are presented in Table 2. Distant targets varied in size to a greater extent compared with those used at near which resulted in greater variation in the distance acuity demand. One way ANOVA showed that there was significant variation between schools in terms of the target sizes of learning materials used and thus their visual acuity demands ($p<0.05$).

Insert Table 2 here

Contrast levels

The contrast levels and reserves for distance and near materials are summarised in Table 3. While contrast levels of learning materials used at distance and near reduced gradually throughout the day, repeated measures ANOVA showed that this decrement was not statistically significant ($p>0.05$). Contrast levels at distance were higher than near at all times, with both distance and near contrast values showing wide variation between classrooms; however, this variation was not statistically significant between schools ($p>0.05$).

Insert Table3 here

Classroom activities

In a typical school day, 70% of the time (263 ± 37 minutes) was spent performing academic-related tasks that involved visual input. The remaining 30% of the time was spent on non-academic tasks, including lunch breaks and transition times between lessons. The breakdown of academic-related tasks included distance (29%), near (47%), distance to near (15%) and computer-based tasks (9%). Students were required to engage in continuous near and distance fixation tasks for 23 ± 5 minutes and 18 ± 5 minutes at a time respectively. These sustained activities included continuous reading or undertaking tests at near and watching videos on smart boards at distance. During distance to near tasks, such as copying from the board, students performed 10 ± 1 fixation changes per minute; students were also expected to sustain the fixation change task for 13 ± 4 minutes at a time.

DISCUSSION

This is the first study to provide a comprehensive evaluation of the visual skill levels required by children in modern primary school classrooms. These findings indicate that a considerable amount of learning activities (70% of the school day) involve visually-based tasks and this supports previous studies which have anecdotally suggested that vision has an integral role (estimated as occupying up to 80% of the time) in the learning process at school.[3,36,37]

Despite suggestions that the size of classrooms is an important factor for learning in schools,[12] there is limited evidence regarding what constitutes an optimum classroom size. Compared with a USA-based study,[5] the classrooms included in this Australian-based study were approximately 30% smaller in size with less space allocation for students ($1m^2$ /student less). The mean illumination levels recorded in the current study mostly complied with the Australian Standards; however up to 10% of observed classrooms did not.[17] Interestingly, the front section of every classroom always had the lowest illumination levels, which could be intentional in order to reduce potential reflective lighting or glare as white or smart boards are usually positioned in this location. One quarter of classrooms, nonetheless, had illumination in this front section of the classroom below recommended levels. However, there was a large variation in illumination levels recorded in each classroom at every time point, with some of these values falling below recommended levels. This could be attributed to differences in window positioning which affects the amount of natural daylight in the classroom. In addition, the variations in daily weather conditions during observation periods may have had an impact on the measured illumination levels. It was also found that the illumination levels typically reduced throughout the day, especially between the first (9am) and the last (3pm) measurements.

This study also demonstrated that children regularly need to be able to accurately resolve spatially presented information both at distance and near. The distance (0.33 logMAR) and near (0.72 logMAR) threshold visual acuity demands are similar to those reported by Langford and Hug;[10] 0.37 logMAR for distance and 0.73 logMAR for near in a single Year 5 classroom. The distance acuity demand was always greater than near in all classrooms. However, both distance and near visual acuity demands varied significantly between schools with greater variation seen in the distance visual acuity requirement compared to near, which was likely to be attributed to differences in individual teacher's handwriting when presenting learning materials on the white or black board. Based upon a recommendation requiring at least 2.5 times acuity reserve,[30,31] the actual near acuity demand for children aged 10 to 12 years old for fluent or sustained reading was found to be 0.33 ± 0.09 logMAR. Consideration of visual acuity reserve in school children is important given that sustained near work (23 minutes) was found to be an integral component of daily classroom activities.

The current study is the first to evaluate the contrast levels of learning materials used in primary school classrooms. On average, the learning materials used in these classrooms had 'moderate' contrast levels of 70% and above,[32] however, these values varied widely, with some of these materials having contrast levels as low as 50%. This can be attributed to the fact that luminance measurements, which were used to calculate contrast levels, are dependent on ambient illumination levels,[38] which varied with classroom location, time of day, prevailing weather conditions (e.g. higher levels would have been recorded on clear compared to cloudy days) as well as individual classroom ergonomics. These variations in classroom illumination therefore also impact on contrast measurements. The findings of the current study also indicate that the contrast level of learning materials used in these modern primary classrooms were above the 20:1 recommended contrast reserve requirement for adults,[33] (on average between 1.5 to 13 times greater over the range of spatial frequencies considered). This suggests that the contrast levels of learning materials were substantially higher than a normally sighted child's contrast threshold, for both higher and lower spatial frequency content.

The majority of the learning activities conducted during classroom observations were those involving near fixation (47%), followed by distant tasks (29%), distance to near tasks (15%) and computer based tasks (9%). These findings differ slightly from those reported by Ritty et al.;[5] near (54%), distance (25%), distance to near (21%) which may be due to the fact that Ritty et al.[5] did not include a computer task category, given that computers were not a mainstream classroom educational device at the time of that study. The current study also demonstrated that the percentage of time allocated for each of the individual learning tasks did not vary significantly between schools, which is likely to be because all of the schools are regulated by DETE and follow a similar education curriculum.

The average estimated near habitual working distance observed in this study, an average of 23 cm (range: 20-25 cm) indicates an estimated accommodative demand of approximately 4 D (range: 4-5 D). Based on the 95% LoA from the agreement pilot study conducted on adults (~ 7 cm), the true working distance is estimated to lie between 16.5 and 28.5 cm which provides a potential range of near accommodative demand of between 3.51 and 6.06 D. It has been suggested that the accommodative amplitude should be at least twice the dioptric equivalent of the near fixation distance for comfortable sustained near work.[39] Therefore, children should have a minimum of 8 D of accommodation amplitude to perform efficiently in the classroom. Considering the normative amplitude of accommodation for children in this age group (12 D),[40] it can be estimated that 4 D of this amplitude to handle a working distance of 25cm would be comfortably available as it represents approximately 33% of the 12 D amplitude during near tasks. This usage further increases to approximately 67% of the 12 D (8 D) during sustained near work.[39] Children in this age group also display, on average, a small lag of accommodation of 0.30 ± 0.39 D (at 25cm),[41] however, there would most likely be a range of working distances for which near targets would be in focus as target blur is also influenced by pupil size (depth of focus).

The current study also demonstrated that children were often required to smoothly change focus from distance to near (approximately 10 times per minute from a distant [0.15 D accommodative demand] to a near point [4 D accommodative demand]) in order to perform activities such as copying from the white or smart board. This places demand on accommodative facility. Another component of binocular vision which may be of importance for children's performance in school classrooms is vergence; the mean vergence demand in this study was estimated to be 0.86 ± 0.07Δ at distance and 21.94 ± 1.09Δ at near. The short near working distance of the child may lead to an increase in accommodation-driven convergence, which further increases the demand placed on the accommodation-vergence system. Furthermore, children must also be able to smoothly converge and diverge during fixation changes from distance to near, which also highlights the importance of vergence facility. Considering the normative data for these binocular vision parameters in children of this age group (10 to 12 years), it could be suggested that children with normal binocular function (within the clinically accepted range for their age) will be able to cope with these visual demands placed on the accommodation-vergence system for short-term tasks; binocular accommodation facility (11 cycles per minute), vergence facility (14 cycles per minute), near fusional reserve break/recovery (base out:17/12Δ, base in:10/7Δ) and distance fusional reserve break/recovery (base out:17/12Δ, base in:7/4Δ).[26,42] However, the sustained distance to near tasks observed in this study lasted for over ten minutes on average. Therefore, children with clinically normal binocular vision may not be performing at their optimum visual efficiency following longer duration classroom tasks typically required of children in Years 5 to 6.

Sustained near work was another important aspect of daily classroom learning activities. Children were required to engage in prolonged near fixation tasks for an average of 23 ± 5 minutes at a time; significantly longer than reported previously (16 minutes).[5] Therefore, the ability of children to meet the demands placed on the visual system, in particular the accommodation and vergence systems, may be compromised when the effort needs to be sustained for an extended period. Collectively, these findings indicate that a well-functioning binocular system is an important requirement for children to enable them to perform learning tasks efficiently. This has implications for provision of paediatric clinical care, however further work is required to establish more specific minimum criteria for binocular vision parameters that would enable optimum performance of the visual system at school.

The current study also showed that 9% of daily academic activities relied on the use of computers (mainly desktop and in some instances laptop computers). The use of modern technologies places greater demand on the visual system due to differences in working distance, viewing angle and the display as compared to using hard copy materials.[43] Targets appearing on screens usually lack sharp edges compared to printed materials, resulting in added difficulty in resolution.[44] Other factors such as the different viewing angles and the need for frequent changes in eye movements across the screen or from the key board to screen also places additional demands on the visual system.[45]

The findings of this study have a number of important clinical implications. Information on visual demands will provide guidance to eye care practitioners when prescribing optometric interventions for visual problems such as low uncorrected refractive errors and non-strabismic binocular anomalies in children. The study findings also reinforce the importance of more thorough school vision screening protocols which include evaluation of binocular vision parameters as well as refractive status when examining school children, which is in line with recommendations by the American Optometric Association.[11] This is crucial given that academic tasks in modern classrooms depend on a variety of visual parameters which are not always included in vision screening batteries, such as accommodation (amplitude, facility) and vergence (reserves, facility) components. The findings of this study also contribute evidence for more definitive pass/fail criteria for paediatric vision screenings.

The study findings may also benefit teachers and school authorities. Teachers should consider factors such as the text size, colour and contrast when preparing learning materials, both printed and computer-based (e.g. presentations on smart boards) to ensure these materials have high resolution, adequate print size and contrast. School administrators and teachers should also ensure that lighting levels are appropriate depending on the tasks being performed by modifying artificial light sources and considering natural lighting variation in classrooms. These findings may also be used as a reference in determining the type of assistance and adjustment that may be necessary for children with visual impairment. Enlarged print with maximum contrast would provide better resolution for these children with visual impairment,[46] and use of adaptive technologies such as desktop or portable electronic magnifiers or -tablet-based applications with contrast enhancement options may be of benefit to visually impaired students.[47] Modification of classroom activities may also be required, such as the inclusion of sufficient break times between activities,[48] or providing extra time to complete certain tasks.

The findings of this study should also be considered in light of some potential limitations. While a large number of schools were included in this study, all were state schools and generally located in urban regions. It would have been ideal to include a wider range of schools, including those in rural and lower socio-economic regions. Furthermore, the classrooms included only two schooling levels, which may limit the extent to which the results of this study can be generalised to other year levels. In addition, a number of the parameters included in this study were determined through estimation or observation given that methodological (ethical) constraints prevented the acquisition of direct measurements involving children in participating classes. Future studies should be planned that take into consideration these limitations.

CONCLUSION

The results of this study demonstrate that higher than expected levels of visual acuity, contrast demand and sustained accommodative and vergence ability are required in order to perform efficiently in the modern Australian primary school classroom. This study provides new evidence regarding the importance of a well-developed overall visual system for children in primary schools. It further serves to justify the need for early identification and treatment of common visual problems, such as uncorrected refractive error and binocular vision anomalies, which may adversely affect academic performance. In addition, these findings are important for determining evidence-based prescribing guidelines for children and guiding the development of more comprehensive and thorough paediatric vision screening protocols.

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