Visual demands in primary school classrooms

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INTRODUCTION AND AIMS

- Good vision is considered to be important for optimal school performance in children, as 80% of learning is believed to be based on visual input[1-3]
  - Misconception exists that standard measures of visual acuity provides a complete representation of the visual system
- However, it is likely that a range of visual function are required to perform efficiently in school[4,5]
  - Including contrast sensitivity, eye movement control, focusing response and binocular coordination
  - However, the levels of visual function required to perform adequately in a classroom are not known
- The aim of this study was thus to quantify the levels of visual function required to perform in modern primary school classrooms

METHODS

- 33 Year 5 and 6 classrooms of from 8 primary schools (children aged 10-12 years) were included for assessment
- Full day observation (9am to 3pm) were carried out in each classroom
  - A regular schooling day was selected
  - Additional observers were included to perform the estimation-based measurements
- A range of measurements were conducted:
  - Classroom setting - physical dimensions
  - Illumination level- each classroom was divided into 5 quadrants (Figure 1) and measurements were obtained at three intervals in a day (9am, 12.30pm, 3pm)
  - Learning materials at distance and near-text size and contrast
  - Habitual working distances - distance and near viewing
  - Classroom learning activities - time spent on different type of academic tasks (classified into 'distance', 'near', 'distance to near' and 'computer' tasks)

Quadrant 5 (Q5)	Quadrant 3 (Q3)
Quadrant 4 (Q4)	Quadrant 2 (Q2)
Quadrant 1 (Q1)	

Figure 1

- Measurements were used to calculate the theoretical visual demands with respect to:
  - Visual acuity: the threshold requirement was calculated using the maximum viewing distance and smallest resolvable detail of the distance and near targets. The threshold values were converted to visual acuity demands assuming an acuity reserve of 2.5X[6]
  - Contrast: luminance levels were quantified and converted to contrast levels using Weber's contrast formula. Measurements were obtained at three intervals in a day
  - Accommodation-vergence: determined using the habitual working distances and the amount of time spent performing different types of learning activities
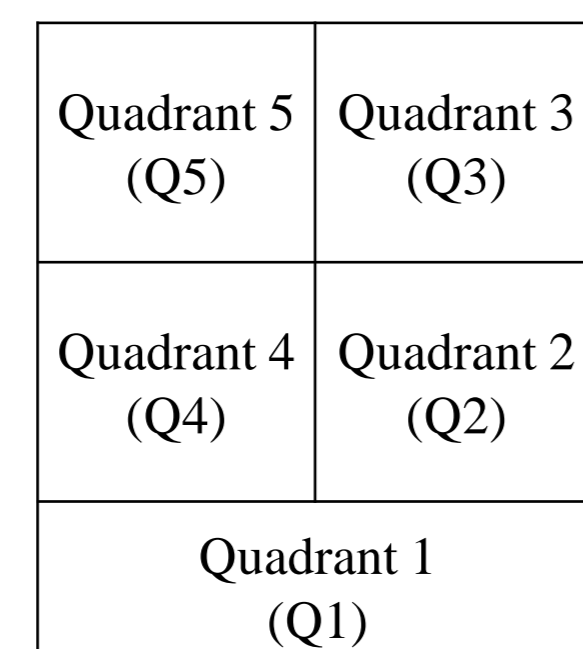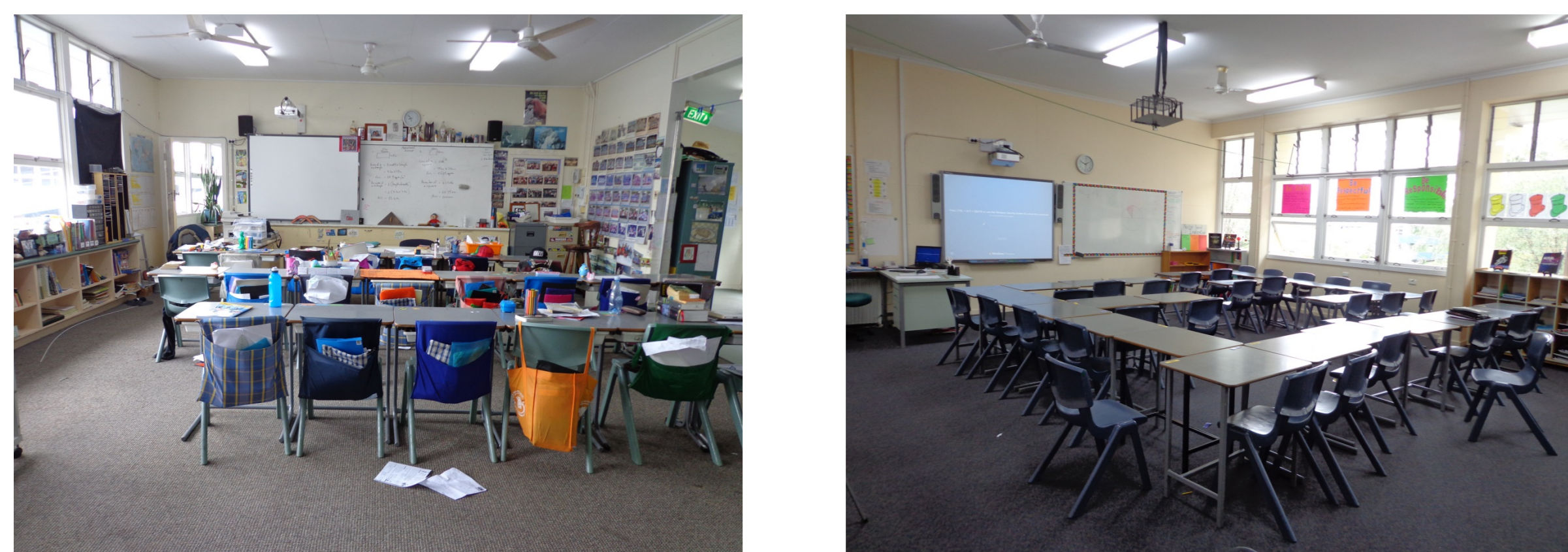

Figure 2: Examples of classroom settings

CLASSROOM DIMENSIONS AND ILLUMINATION

- The average dimensions of the classrooms were 7.74 ± 0.79m long and 6.97 ± 0.87m wide
- Each classroom was occupied by 27 ± 2 students, with a space allocation of 2m² per student
- Classroom illumination levels varied significantly with quadrant position (p<0.001) and time of day (p<0.001)
- The front section (Q1) of the classroom always had the lowest illumination level later in the day (3pm) (Figure 3)
  - Possibly to reduce reflective glare as white and smart boards were generally located at the front of the classroom
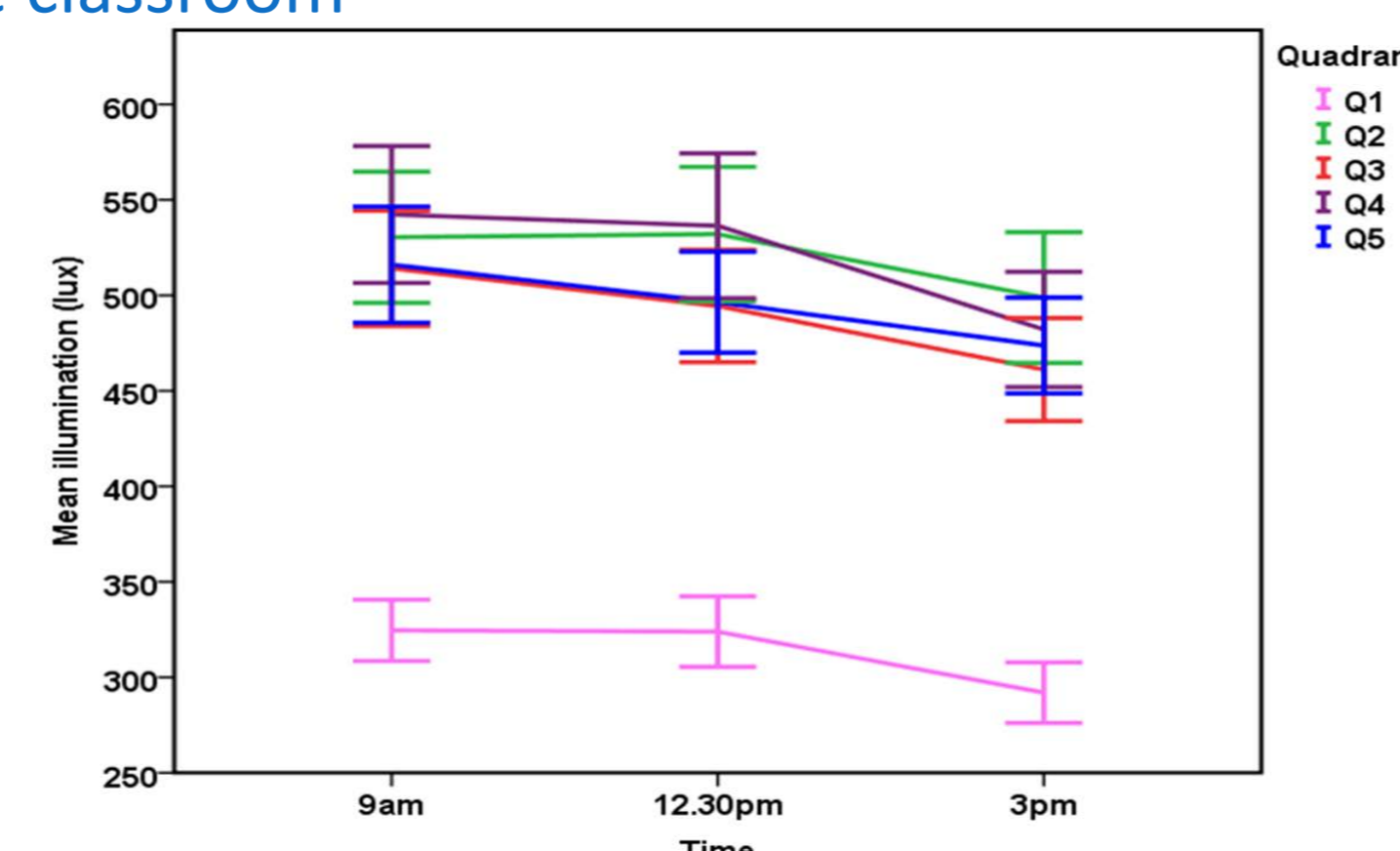

Figure 3: Classroom illumination levels

VISUAL ACUITY

- A variety of learning materials were used in each classroom
  - Distance: presentation on smart board or writing on white/black board
  - Near: printed materials and workbooks
- Distance acuity demand was always greater than near in every classroom

Table 1: Average visual acuity demand

	Acuity Threshold (logMAR)	Acuity Demand (logMAR)
Distance	0.33 ± 0.13	0.13 ± 0.05
Near	0.72 ± 0.09	0.29 ± 0.04

CONTRAST LEVELS

- Contrast levels of learning materials both at distance and near decreases gradually in a day, however this decrement was not statistically significant
- Average distance contrast levels were always higher than near at every measurement time

Table 2: Average contrast levels

Time	Position of material	Average (SD) %	Mean contrast reserve
9am	Distance	81.53 (12.44)	27:1
	Near	79.79 (9.30)	27:1
12pm	Distance	78.12 (11.76)	26:1
	Near	76.36 (8.98)	25:1
3pm	Distance	75.36 (11.54)	25:1
	Near	72.75 (8.81)	24:1

ACCOMMODATION-VERGENCE

- 70% of the time in a day was spent on academic tasks requiring visual input (Figure 4)
- Near tasks were the predominant type of learning activity
- Average near working distance was 23cm (4 D accommodation demand)
- Children were required to sustain continuous fixation for 23 minutes at near and 18 minutes at distance
- Children also performed fixation changes 10 times per minute
- The average vergence demand was 0.86 ± 0.07Δ at distance and 21.94 ± 1.09Δ at near (assuming pupillary distance of 56mm)

Figure 4: Time spent performing different learning tasks

- Distance 29%
- Near 47%
- Distance to near 15%
- Computer 9%
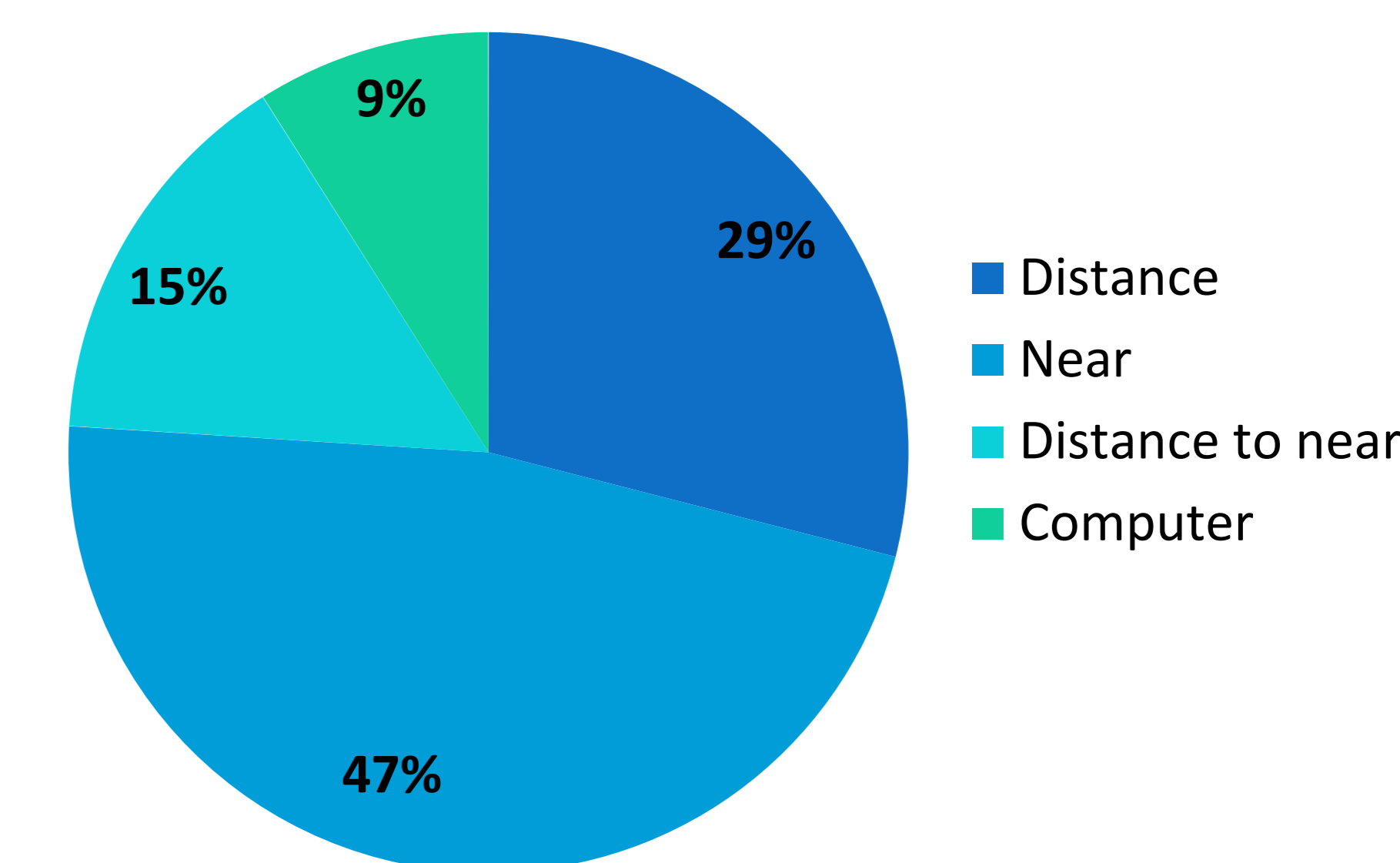
DISCUSSION

- The majority of learning activities in classrooms are visually based
- Multiple demands are posed on a child's visual system, with higher than expected levels of demand recorded
- A well-developed visual system, in which all the parameters are within the clinically accepted range for their age, is an important requirement for optimal school performance
- The findings from this study have a number of implications for clinical practice and schools:
  - Development of evidence-based paediatric optometric management guidelines for eye care practitioners especially for children suspected of vision-related learning problems
  - Development of a comprehensive school vision screening protocol by indicating the tests to be included and cut-off criteria for referral
  - Highlights the importance of early identification and treatment of visual anomalies in children such as uncorrected refractive errors and binocular vision dysfunctions
  - Guide for teachers in the preparation of learning materials and planning of daily classroom activities to ensure a comfortable learning environment
  - Evidence for determining the type of assistance and adjustment for children with irreversible visual impairment who are integrated in standard school environment
- Future studies should examine visual demands of children from schools of varying geographical and socioeconomic areas, and also from different schooling year levels

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