Accommodative Facility in Eyes with and without Myopia

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PURPOSE. To compare accommodative facility in eyes with myopia to that in eyes with emmetropia or hyperopia and to determine whether accommodative facility can be used to predict an association with myopia.

METHODS. In the Sydney Myopia Study, year-1 school children (6.7 ± 0.4 years) were assessed for accommodative facility at distance (3 m) and near (33 cm) with semiautomated flippers. Spherical equivalent refractive error (RE) was defined as myopia (≤ -0.50 D), emmetropia (> -0.50 D, but $< +1.50$ D), and hyperopia ($\geq +1.50$ D) based on postcycloplegia readings. Only right eye data were considered. Differences between groups were analyzed with the Brown-Forsythe F test after adjustment for age and gender. Multiple comparisons were adjusted with the by the Games-Howell method.

RESULTS. Of the 1328 right eyes assessed, 20 (1.5%) eyes were myopic, 977 (73.6%) were emmetropic, and 331 (24.9%) were hyperopic. At distance, mean facility was less for myopic eyes at 5.5 ± 2.0 cycles per minute (cpm) in comparison to 6.9 ± 1.7 cpm for eyes with emmetropia or hyperopia ($P = 0.005$). Myopic eyes recorded greater positive and negative accommodative response times than did emmetropic or hyperopic eyes ($P < 0.05$). There were no differences among the groups in near facility. The area under the receiver operating characteristic (ROC) curve for distance facility was 0.692 ($P = 0.003$, 95% CI, 0.580–0.805).

CONCLUSIONS. Myopic eyes have reduced accommodative facility at distance, and accommodative responsiveness to both positive and negative defocus is slow. However, accommodative facility as a test does not have sufficient power to discriminate eyes with myopia from other refractive errors. (*Invest Ophthalmol Vis Sci.* 2006;47:4725–4731) DOI:10.1167/iovs.05-1078

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An association between near work activity and myopia[1–8] has led investigators to postulate that the action of the crystalline lens, particularly accommodation, is involved in the development and progression of myopia. In essence, the lack of an accurate accommodative response equates to periods of retinal defocus or blur, and it has been well documented using animal models that retinal defocus leads to increased eye growth and myopia.[9–11] Various measures of accommodation such as amplitude of accommodation, tonic accommodation, accommodative adaptation, accommodative stimulus response curves, and near-work–induced transient myopia have been investigated,[12–19] and there is growing evidence from these studies to suggest that errors of accommodation are associated with myopia.[13–15] Despite these findings, however, the mechanism by which accommodation could affect the development of myopia is not fully understood and, of importance, there is no single measure of accommodation that can be used to predict an association with myopia.

Facility of accommodation measures the speed of accommodative responsiveness (ability to alter accommodation rapidly and accurately) to blur, using alternating negative–plano or negative–positive lenses to induce and relax accommodation. O'Leary and Allen[20] measured the facility of accommodation in young adults with myopia and found the mean distance facility to be significantly lower in the myopic than in the emmetropic subjects. They reported that although the test was not sufficiently discriminating between subjects with and without myopia, it held promise as a predictive test. Facility of accommodation can also be measured in young children at an age when myopia first develops (i.e., 5–6 years), as the test is rapid, noninvasive, and easily comprehensible and reproducible. Using targets and an instructional set appropriate for young children, investigators have measured both monocular and binocular accommodative facility in children between the ages of 6 and 12 years.[21,22]

The Sydney Myopia Study is a population-based project, which was primarily designed to document the age-specific prevalence of myopia in a large, representative sample of children attending primary and secondary schools across Sydney, Australia. In the first phase of the study, year-1 children attending 34 primary schools were selected in a stratified random cluster design based on socioeconomic status, and a comprehensive eye examination was conducted. Facility of accommodation for distance and near was conducted as part of the study protocol. In this report, we sought to compare facility of accommodation in eyes with myopia compared with eyes with emmetropia or hyperopia.

MATERIALS AND METHODS

Subjects

A population of 1774 primary school children (year 1, mostly aged 6 years) were enrolled in the Sydney Myopia Study.[23] The study commenced on 13 August 2003 and was completed for year-1 children on 27 August 2004. As mentioned, it was conducted in 34 primary schools across the Sydney metropolitan region. Of the 1774 children, those who did not undergo cycloplegia after accommodative facility testing were not included in the analysis, as only postcycloplegia refractive error measurements were used to categorize the children into various groups. Only the data from the right eye were considered for analysis. Cycloplegia was achieved with two cycles of 1% cyclopentolate (1 drop) and 1% tropicamide (1 drop) instilled 5 minutes apart after corneal anesthesia with amethocaine 1% hydrochloride. In a small proportion of children whose pupils were slow to dilate, 2.5% phenylephrine was used to maximize mydriasis.

Data were also excluded from the analysis for children with (1) a cylinder component ≥ ±1.00 D or cylinder component of refractive error greater than spherical component for myopes; (2) pupil diameter <5 mm; and (3) visual acuity in the right eye <6/7.5 at 3 m. Refractive error was measured with an aberrometer (Complete Ophthalmic Analysis System [COAS]; Wavefront Sciences, Albuquerque, NM) and spherical equivalent data using the Seidel sphere option was used to categorize the refractive groups. Refractive error was defined as myopia (spherical equivalent refractive error of ≤ −0.50 D), emmetropia (spherical equivalent refractive error of > −0.50 D, but < +1.50 D), and hyperopia (spherical equivalent ≥ +1.50 D). This article reports the data for 1328 children who met the criteria for analysis. Table 1 details the biometric data for age, sex, and spherical equivalent for the various refractive groups. Before the examination, written consent from at least one parent was obtained in addition to the child's verbal consent. All procedures conducted conformed to the Declaration of Helsinki. Ethics approval for the study was obtained from the University of Sydney and the University of New South Wales.

Measurement of Facility of Accommodation

Instrument. Facility of accommodation was measured with semiautomated lens flippers. In comparison to a manual flipper, the semiautomated flipper ensured the accuracy of the measurement of the number of cycles per minute (cpm) and also recorded the duration of the positive and negative accommodation response times in milliseconds. In brief, the semiautomated flipper was constructed using a standard flipper mounted on a handle attached to a mercury switch (plano/−2.00 D lens for examining distance facility and +2.00 D/−2.00 D lens for near facility). The mercury switch, when flipped, triggers the circuit, and the information is relayed via cable to a computer, which records the duration and frequency of each phase by means of a flipper software program. The flipper software recorded the number of flipper cycles and half cycles for distance and near, time taken by the eye for each period of positive accommodation response (time to clear −2.00 D for distance and near) and negative accommodation response time (time to clear plano for distance or +2.00 D for near). Each flip constituted a half cycle and two consecutive flips a full cycle.

Procedures. Accommodative facility was measured only in the right eye of each subject at both 3 m (for distance facility) and 0.33 m (for near facility). In the Sydney Myopia Study, accommodative facility was conducted before cycloplegic refraction but after habitual VA or corrected VA testing for distance/near, phorias, and color vision testing and stereo acuity. For distance and near facility, a modified version of the McMonnies-Ho high-contrast letter chart was used and presented as four color-coded subcharts with a black cross at the center of the chart (Fig. 1). For distance, the chart was mounted on a board, and for near, the chart was mounted on a wooden board with an adjustable neck strap, to ensure a constant working distance of 33 cm. Illumination was maintained at 700 lux by specially positioned incandescent lamps and measured by light meter before each examination. The left eye was occluded with an opaque sterile patch.

Of the 1328 children, 45 wore spectacles (5 children with myopia, 21 with emmetropia, and 19 with hyperopia). All children were able to read the 6/7.5 line on the chart at 3.0 m, either unaided or with their habitual spectacles in place.

The child was then shown a sample of letters from the alphabet—F, U, H, R, Z, E, P, N, D, and V—to determine whether they could be correctly named. If the letters could not be identified, a sample of numerals was shown. The target line for accommodative facility testing corresponded to 6/7.5 (N5 near acuity). The four subcharts had a red, green, yellow, or blue block next to the first letter of each respective subchart (Fig. 1). It was explained to the child that the row of letters with a red "block" would be referred to as the "red line," even though the letters were black, the row of letters with a green block as the "green line," and so on. The child was instructed that he or she would be asked to read the first or the last letter on the red, green, yellow, or blue lines while looking through different glasses. A +1.00-D spherical trial lens was used briefly (for 1–2 seconds) to demonstrate blur or fogginess on the distance chart. The child was told that if he or she kept looking, the blur would usually disappear and the letters (numbers) could be read. The measurement then commenced, and the child was asked to look at the black cross in the center of the chart. For distance measurements, the −2.00-D side of the distance flipper was always placed first before the subject's right eye, the red button on the flipper was simultaneously pressed (this started the timer in the flipper software for the first cycle), and the subject was asked: "What is the first letter/number on the red line?" When the child correctly identified and read out the letter/number, the flipper was turned to the plano side (a beep would signify the flip and the commencement of timing of the next cycle by the software) simultaneously with the question "What is the first letter/number on the green line?" and the child was directed with the question to the next subchart. If the child incorrectly identified the target letter, the flipper remained stationary until it could be correctly identified. The test progressed for 60 seconds until the clock was automatically stopped by the software. The child was given random checks to verify nonmemorization by modifying the sequential order of naming the red line, green line, yellow line, and blue line. A similar procedure was conducted at near with +2.00/−2.00-D flippers. The order of testing distance facility or near facility first was randomized. The interval between the two facility measurements (i.e., distance and near or near and distance) was 90 seconds, to provide a break for the child and to ensure a return to baseline state from any accommodation induced aftereffects.[24]

If a child was not able to clear the first lens (−2.00 D) within 1 minute, the facility was recorded as 0 cycles and the response time recorded as 60 seconds.

Statistics

For both distance and near accommodative facility, the mean and SD were reported in both cpm and the positive and negative accommodation response times. Eyes with 0 cpm were included in the analysis. The sizes of the three refractive error groups were unequal, and the Brown-Forsythe F test[25] was therefore used to compare the means among the three groups. The type I error rates of the Brown-Forsythe

TABLE 1. Biometric Data for 1328 School Children

	Age (y) Mean ± SD (Range)	Male:Female (%)	Spherical Equivalent Mean ± SD (Range)
All (n = 1328)	6.7 ± 0.4 (5.5–8.0)	686 (51.7%):642 (48.2%)	+1.14 ± 0.71 (−3.34 to +5.25)
Myopes (n = 20)	6.7 ± 0.4 (5.9–7.3)	8 (40%):12 (60%)	−1.16 ± 0.67 (−0.53 to −3.34)
Emmetropes (n = 977)	6.7 ± 0.5 (5.5–8.0)	517 (52.9%):460 (47.1%)	+0.90 ± 0.39 (−0.46 to +1.49)
Hyperopes (n = 331)	6.7 ± 0.5 (5.7–7.6)	161 (48.3%):170 (51.7%)	+2.00 ± 0.55 (+1.50 to +5.25)

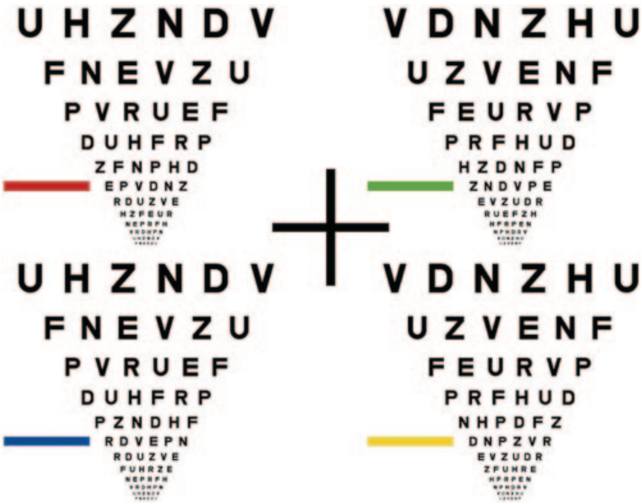

FIGURE 1. Modified McMonnies-Ho chart used for testing facility at distance.

F test are close to the predetermined α levels ($P = 0.05$), even when assumptions of normality and variance are violated.[26] After a significant result, multiple comparisons were performed with the Games-Howell adjustment. This method has been recommended in situations of unequal sample sizes and unequal or unknown variances.[27] The level of statistical significance was maintained at $P < 0.05$.

RESULTS

Of the 1328 right eyes, 20 (1.5%) were myopic, 977 (73.6%) emmetropic, and 331 (24.9%) hyperopic.

Accommodative Facility at Distance

Number of Cycles Per Minute. The mean facility for the entire study population was 6.9 ± 1.8 cpm (Table 2). After adjustment for refractive error groups and gender, age was significantly associated with cpm with more cpm recorded with increasing age (F = 17.29, $P < 0.001$). However, the interaction of age with refractive error groups was not significantly associated with cpm (F = 0.98, $P = 0.401$). From the main-effects model, gender was not associated with cpm (F = 1.96, $P = 0.161$).

The mean facility for myopic eyes was 5.5 ± 2.0 cpm, whereas both emmetropes and hyperopes recorded 6.9 ± 1.7 cpm. There was a significant difference between the groups (F = 5.74; $P = 0.005$), with myopic eyes recording a significantly lower number of cpm than emmetropic and hyperopic eyes ($P = 0.013$). There were no differences between emmetropic and hyperopic eyes ($P = 0.981$). Figure 2 presents the frequency distribution of the distance facility in all three groups. Whereas the distribution for both emmetropic and hyperopic eyes appeared normal, the frequency distribution for myopic eyes appeared skewed to the left. A single myopic eye and two hyperopic eyes were unable to clear the −2.00-D side of the flipper for distance and recorded a facility of 0 cpm.

Further, eyes with emmetropia were divided into two groups (group I: more myopic, > −0.50 to ≤ +0.50 D; group II: less myopic, > +0.50 to ≤ +1.50 D) to determine whether any of the subgroups showed an association with distance facility. The facilities are given in Table 3, and the difference between the two groups was not statistically significant ($P = 0.322$). Also, the two subgroups were different in eyes with myopia but not in eyes with hyperopia.

Accommodative Response Time. Data for positive accommodative response were analyzed twice. The first set included data from eyes that recorded 0 cpm (analysis time of 60 seconds) and the second set excluded those eyes with 0 cpm. It was found that myopic eyes recorded greater positive and negative accommodative response times (or took longer to clear the lens placed in front of the eye) in comparison to emmetropic and hyperopic eyes, and the difference reached significance in the set that excluded eyes with 0 cpm ($P < 0.05$, Table 4). There were no differences between emmetropic and hyperopic eyes ($P > 0.05$).

Data were further analyzed to determine whether it is possible to distinguish between myopic and nonmyopic eyes by using distance facility. The sensitivity and specificity for the distance cycles per minute were calculated along with the area under the receiver operating characteristic (ROC) curve. The area was 0.692 ($P = 0.003$, 95% CI, 0.580–0.805), suggesting that distance cpm had only a fair ability to discriminate between myopic and nonmyopic eyes. Also, predictive values plus sensitivity and specificity were computed for three categories of distance cycles per minute, to determine whether distance cycles per minute can be used as a predictive measure (Table 5). The highest negative predictive value for myopia was distance cpm > 7 (99.4%, sensitivity 85.0%). Of the positive predictive values, the most predictive was for cpm ≤ 5 (3.7%, sensitivity 45.0%).

Accommodative Facility at Near

Number of Cycles per Minute. As with distance facility, after adjustment for refractive error groups and gender, age was significantly associated with near cpm, with more cpm recorded with increasing age (F = 11.45, $P < 0.001$). However, the interaction of age with refractive error groups was not significantly associated with cpm (F = 0.89, $P = 0.445$). From the above main-effects model, gender was not associated with cpm (F = 3.1, $P = 0.081$).

The difference in near facility between the three groups was not significant (F = 1.74; $P = 0.184$; Table 2). Figure 2 depicts the frequency distribution of monocular near facilities for myopic, emmetropic, and hyperopic eyes. The data appeared to be normally distributed.

Accommodative Response Time. One subject with hyperopia had a 0 facility at near and one with myopia had a reduced facility of 1.5 cpm with a positive accommodative response time of 27 seconds. The data were analyzed in two ways: the first analysis included all eyes and the second ex-

TABLE 2. Distance and Near Facility

Refractive Status	Mean ± SD	Range
Distance facility		
Myopes (n = 20)	5.5 ± 2.0	0–8.5
Emmetropes (n = 977)	6.9 ± 1.7	2–14
Hyperopes (n = 331)	6.9 ± 1.7	0–12
Total (n = 1328)	6.9 ± 1.8	0–14
6 y (n = 430)	6.5 ± 1.5	0–10.5
7 y (n = 861)	7.0 ± 1.8	0–12.5
8 y (n = 37)	7.8 ± 2.3	4–14
Near facility		
Myopes (n = 20)	6.4 ± 1.8	1.5–9
Emmetropes (n = 977)	7.0 ± 1.5	3–14
Hyperopes (n = 331)	6.9 ± 1.5	0–12
Total (n = 1328)	6.9 ± 1.5	0–14
6 y (n = 430)	6.7 ± 1.4	3.5–10.5
7 y (n = 861)	7.0 ± 1.5	0–11.5
8 y (n = 37)	7.6 ± 2.2	3.5–14

Data are expressed in mean cycles per minute.

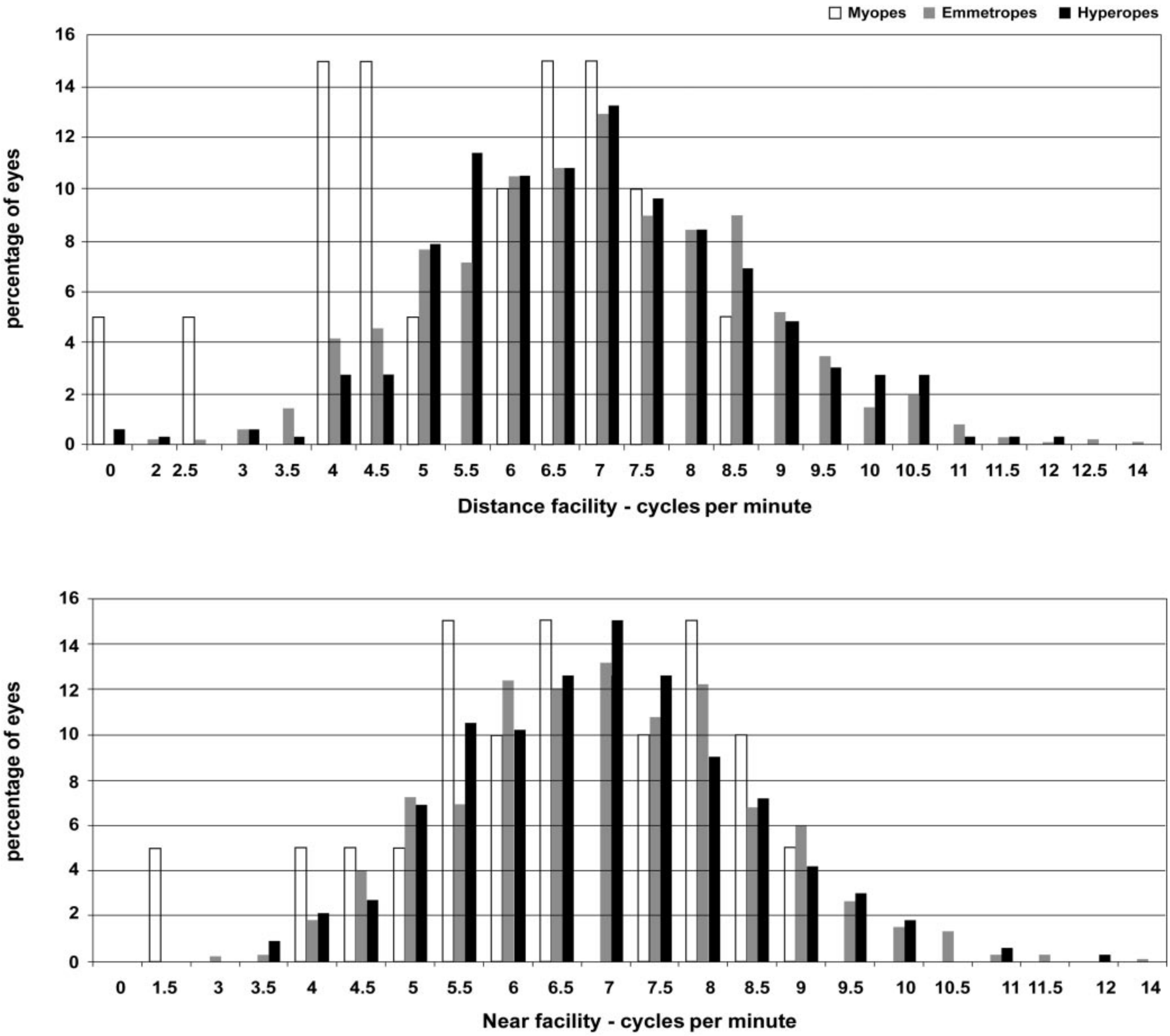

Figure 2. Frequency distribution of the mean distance and near facility for myopic, emmetropic, and hyperopic eyes.

cluded the eye with 0 cpm. For both the sets, the data showed no difference in the positive and negative accommodative response times between groups (Table 6).

Discussion

Prevalence rates for myopia, emmetropia, and hyperopia in the present study (by eye) were 1.5%, 73.6%, and 24.9%, respectively. Details of the prevalence and associations with refractive error in the Sydney Myopia Study are reported elsewhere.[28]

For the entire study population, the monocular accommodative facility at distance was 6.9 ± 1.7 cpm which is similar to other reports of accommodative facility data measured for distance in similar age groups.[21,22] In this study, there was a positive correlation between the speed of accommodative re-

Table 3. Distance Facility for Subgroups of Eyes with Emmetropia and Comparison to Eyes with Myopia and Hyperopia

	Cycles per Minute		Multiple Comparison Test (P)	
Refractive Status	Mean ± SD	Range	Myopia	Hyperopia
More Myopic (n = 139)				
>−0.50 D to ≤+0.50 D	6.7 ± 1.8	2–11.5	0.002	0.381
Less Myopic (n = 838)				
>+0.50 D to ≤+0.50 D	6.9 ± 1.7	2–14	0.001	0.989

TABLE 4. Positive and Negative Accommodation Response Times for Distance

Refractive Status	Mean ± SD (ms)	*P*
Positive accommodation response time		
Myopes ($n = 20$)	8,630 ± 12,259	0.193
Emmetropes ($n = 977$)	4,804 ± 1,619	
Hyperopes ($n = 331$)	5,010 ± 4,482	
Positive accommodation response time (excluding eyes with 0 cpm)		
Myopes ($n = 19$)	5,926 ± 2,074	0.015
Emmetropes ($n = 977$)	4,810 ± 1,616	
Hyperopes ($n = 331$)	4,675 ± 1,288	
Negative accommodation response time		
Myopes ($n = 19$)	5,040 ± 1,826	0.010
Emmetropes ($n = 977$)	4,076 ± 1,216	
Hyperopes ($n = 329$)	4,053 ± 1,092	

sponsiveness (cpm) and increasing age, for both distance and near facility. Previous reports have also confirmed an increasing trend in accommodative facility with age, particularly during the early years of schooling; accommodation appears to stabilize as children progress into adulthood.[22] This trend toward improvement with age may be due to a higher level of understanding and ability to respond to the task rather than to an actual increase in accommodative responsiveness; if so, it is a significant drawback to this procedure.

However, within the present study population, this study showed that accommodative facility at distance (3 m) was reduced in myopic eyes in comparison to emmetropic and hyperopic eyes. This association of reduced facility in myopia was independent of association with age. Despite the automated parts of the test, the procedure still relied on an examiner to flip the switch and raises the possibility of an examiner bias, as they were not masked to the subject's refractive status. Although it cannot be ruled out completely, we believe that the risk of such a bias was minimal due to the following reasons: (1) The procedure simply relied on measuring the accommodative facility with the child's habitual correction in place and did not require the examiner to go through the study folder to determine refractive status; and (2) the test was conducted before cycloplegia, and therefore an accurate account of the refractive status was not available. Previous studies have reported reduced accommodative responsiveness when negative lenses are used.[14,15] Also, O'Leary and Allen[20] reported adult myopes to have lower accommodative monocular distance facilities (9.7 ± 6.3 cpm) in comparison to adult emmetropes (15.6 ± 6.8 cpm).[20] They suggested that lowered distance accommodative facility could be one of several contributing factors to myopia progression.[29] There were no differences in the accommodative facility at near between myopic versus nonmyopic eyes in our study.

When the data were further analyzed by accommodative response time, it showed that both the positive (time taken to induce accommodation) and negative (time taken to relax accommodation) accommodation response times for distance were longer in myopic than in nonmyopic eyes. On average, the myopic eyes took a second longer to induce or relax accommodation and clear the induced blur. Although O'Leary and Allen did not report any differences in distance negative response times, other investigators have reported that myopes demonstrate greater susceptibility to post–near-task myopic shifts that take longer to return to the baseline refractive state.[16] Reasons, if any, for this delay or sluggish response to accommodative defocus are not clear, but studies have suggested that this delayed response may only be a feature of progressive myopia, not stable myopia.[16] The presence of significant ocular aberration is thought to produce reduced sensitivity to blur which in turn reduces accommodative responsiveness. However, results to date are mixed on whether aberrations differ between myopic and nonmyopic eyes.[30–33] Radhakrishnan et al.[34] reported that when myopic eyes are corrected with negative lenses for distance, the optimum focus for high-spatial-frequencies peak lies on the retina and the mid-spatial-frequencies peak is shifted to in front of the retina. When the eye then switches focus from distance to near objects, the shift causes the focus for mid-spatial-frequencies peak to be positioned on the retina and that for the high-spatial

TABLE 5. Distance Facilities for Predicting Myopia

Distance Facility	Myopes	Nonmyopes	Total
≦5 cpm			
Frequency	9	235	244
% within cpm (predictive values)	3.70	96.30	100.00
% within refractive error groups	45.0	17.90	18.30
5.5–7 cpm			
Frequency	8	556	564
% within cpm (predictive values)	1.40	98.60	100.00
% within refractive error groups	40.00	42.50	42.50
>7 cpm			
Frequency	3	517	520
% within cpm (predictive values)	0.60	99.40	100.00
% within refractive error groups	15.0	39.50	39.20
Total			
Frequency	20	1308	1328
% within cpm (predictive values)	1.50	98.50	100.00
% within refractive error groups	100.00	100.00	100.00

Table 6. Mean Accommodation Response Times for Near

Refractive Status	Mean ± SD (ms)	*P*
Positive accommodation response time		
Myopes (n = 20)	5377 ± 5264	0.330
Emmetropes (n = 977)	3949 ± 1000	
Hyperopes (n = 331)	4022 ± 3202	
Positive accommodation response time (excluding eyes with 0 cpm)		
Myopes (n = 20)	5377 ± 5264	0.234
Emmetropes (n = 977)	3949 ± 1000	
Hyperopes (n = 330)	3852 ± 856	
05-1078		
Myopes (n = 20)	4817 ± 1326	0.194
Emmetropes (n = 977)	4705 ± 1331	
Hyperopes (n = 330)	4861 ± 1392	

frequencies behind the retina. It has been suggested that the presence of mid-spatial frequencies on the retina negates the need for the accommodative response. Is it possible that accommodative responsiveness becomes dysfunctional due to disuse? Another hypothesis that is appealing in the current scenario suggests a possible deficit in autonomic innervation (both sympathetic and parasympathetic) during the progressive phase of myopia that produces the sluggish response to accommodative defocus.[35]

While a plano/−2.0-D lens was used for distance, a ±2.0-D lens was used for measurements at near (33 cm), and no differences were found in the accommodative facility at near between myopes and nonmyopes. O'Leary and Allen[20] have found similar results and postulated that these are likely to be a result of learning effects, because near facility was always determined after distance facility in their study. However, in our study, any possible learning effects were minimized by randomizing the order of near and distance facility measurements. While the maximum change in focus for a plano/−2.0-D lens was 2 D, it increased to 4 D with a +2.0 D/−2.0-D lens. It is possible that such big shifts at near have overwhelmed the accommodative system, thus making it difficult to find differences between groups. It would be of interest to repeat the plano/−2.0 flipper measurement at distances closer than 3 m to see whether the result held.

One of the weaknesses of the present study was that facility was not measured with best corrected refractive error in place. Only a small number of the population (45/1328 eyes) wore their prescribed corrections It is then possible that the less-myopic eyes in the emmetropic group and the hyperopic eyes were under greater accommodative stress to clear the positive and negative lenses. Given such a scenario, one would expect the number of cycles to be less and the duration of the accommodative response times especially the positive response times to be greater in hyperopes. However, the data show that the number of cycles were greater in the hyperopic and emmetropic eyes. In addition, there were no differences in the number of cycles between hyperopic and emmetropic eyes, suggesting that leaving the refractive error uncorrected may not have had a significant effect on the facility.

Mutti and Zadnik,[36] reported that the single best predictor of myopia in children is a refraction more myopic than +0.50 D at school entry. In this study, eyes with emmetropia had refractive errors ranging from > -0.50 to $\leq +1.50$ D, and we divided this group into more myopic and less myopic eyes. Of particular interest was the more myopic group, as eyes in this group had refractive error ranging from > -0.50 to $\leq +0.50$ D and fitted the at-risk category described by Mutti and Zadnik. However, the accommodative facility in this group was closer to that in the less-myopic and hyperopic groups rather than the myopic group. The cumulative frequency for distance facility with cpm ≤ 7 was 85.0% in eyes with myopia, 63.8% in eyes with more myopia in the emmetropic group, 59.5% in eyes with less myopia in the emmetropic group and 61.0% in eyes with hyperopia. This information suggests that dysfunctional accommodative responsiveness is more likely to be related to myopia rather than a precursor.

In this study, we also sought to determine whether distance facility could be used as a test to discriminate between myopic and nonmyopic eyes. The test is rapid and can be used in children at an age when myopia is first detected. However, ROC values suggest that accommodative facility cannot be used as a stand-alone discriminatory test for myopia. Although distance cpm > 7 was highly predictive (99.4%) and sensitive for nonmyopia (85.0), the prevalence of myopia in the entire study population was only 1.5%. This finding means that using distance cpm > 7 to discriminate between myopic and nonmyopic eyes could result in many false positives in the population. A more useful measure may be to track eyes for development or progression of myopia. Distance cpm ≤ 5 was seen to be most predictive of myopia (3.7%), and therefore it may be beneficial to track eyes in this group for development or progression of myopia.

In summary, in children aged 6 to 8 years, eyes with myopia have a reduced facility of accommodation at distance, and the accommodative responsiveness to both positive and negative defocus is slow. Because of the cross-sectional nature of the study, the role played by accommodative dysfunction in the development of myopia is not clear, but eyes considered to be at risk of the development of myopia did not reveal any accommodative dysfunction. Evidence also suggests that, although the test may be useful to track eyes for progression or development of myopia, it does not have sufficient power to discriminate eyes with myopia from other refractive errors and cannot be used as a stand-alone test and has some methodological drawbacks due to the subjective nature of the testing process.

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