Influence of education systems on children's visual behaviours as an environmental risk factor for myopia: a quantitative analysis with LIDAR-sensor tracking in classrooms

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Purpose: A pilot study on Hong Kong children in a local and an international school found that, despite a much higher prevalence of parental myopia and high myopia, the myopia prevalence among the international school students is lower than that in the local school, suggesting that environmental factors related to the educational system have a protective effect on myopia development. We quantify this hypothesis by rigorous comparison of the working distance and dynamic visual behaviours in a sub-cohort of these two school systems, using head-mounted distance sensors in the children's classroom setting.

Methods: Children (8-10 years) were recruited from a local (n=28) and an international school (n=27) for high-frequency (10 samples/second) working distance logging in their school day. To track the visual behaviors during 90 minutes of typical lessons in their classroom, each child wore a head-mounted LIDAR as part of a wearable technology ensemble consisting of eye-tracking glasses, and light and distance sensors. Visual behavior was expressed as dioptric viewing distance (1/working distance). To quantify the dynamic nature of the visual behaviour, we calculate the autocorrelation, i.e., the correlation of a dioptric distance with a delayed copy of itself, as a function of delay.

Results: Local schoolchildren on average exhibited a significantly higher dioptric viewing distance (i.e., shorter working distance) in class than international schoolchildren (2.55 ± 0.45 m^{-1} vs. 1.82 ± 0.23 m^{-1}; two-sample t-test, P <0.001). In the local school, emmetropic children showed a slightly larger dioptric distance than myopic children (2.81 ± 0.53 m^{-1} vs. 2.39 ± 0.32 m^{-1}, two-sample t-test P=0.017). No statistically significant difference was found between emmetropic and myopic children in the international school (1.87 ± 0.22 m^{-1} vs. 1.75 ± 0.24 m^{-1}; two-sample t-tests, P=0.182). Interestingly, the dioptric distances of local schoolchildren changed significantly slower than those of international schoolchildren (-0.33 ± 0.10 s^{-1} *vs.* -0.66 ± 0.24 s^{-1}; Kolmogorov–Smirnov statistic (KSs) = 0.77, P=<0.0001). Conversely, no statistical difference was found in the dioptric distance dynamics between emmetropic and myopic children in the same school using the two-sampled KS test (local school KSs = 0.4, P = 0.19 and international school KSs = 0.26, P = 0.68).

Conclusions: Although the association between education and myopia has been well established, only a few studies have compared the risk factors for myopia with children from the same geographical location, but different education systems. Our quantitative analysis based on LIDAR data revealed sizable differences in the static and dynamic visual behaviours of Hong Kong children attending two schools that employ contrasting pedagogical approaches, but not between emmetropic and myopic children within the same school. These results indicate that the education system plays a predominant role in determining children's visual behaviour and thus can be an environmental risk factor for myopia development.

Keywords： myopia, risk factors, environmental risk