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Stereopsis and Artistic Talent: Poor Stereopsis Among Art Students and Established Artists

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Stereopsis is the perception of depth generated from differences between the two eyes' views of a single image; this difference is termed *disparity*. When artists learn to draw, they are often instructed to close one eye; this defeats stereopsis and makes monocular depth cues—such as perspective, occlusion, and shading—more apparent. In this study, we tested the hypothesis that poor stereopsis might therefore be an asset to someone whose goal is to represent the three-dimensional world on two-dimensional surfaces (Livingstone & Conway, 2004).

Method

In Experiment 1, we measured stereoscopic ability in two groups: The first consisted of 403 art students from two U.S. art schools that are respected for their emphasis on representational rendering, and the second group was composed of 190 college students not majoring in art at two universities with tuitions similar to those of the art schools. Subjects viewed computer-generated, dynamic, 100 × 100 random-dot stereograms presented at a distance of 57 cm and spanning 11°. Subjects were first shown a zero-disparity stereogram for 2 s; then a central 4.5º square region of the stereogram was shifted to a nonzero disparity for 2 s and then returned to zero disparity for 2 s. Ten nonzero disparities were shown; each disparity was presented twice for each subject, in random sequence. Subjects were asked whether the central square appeared in the plane of the monitor, in front of it, or behind it.

In Experiment 2, we adapted a clinical test (Hirschberg, 1885) to analyze interocular alignment in photographic portraits of established artists to assess the likelihood that the artists had normal stereopsis. If eyes are misaligned (a condition called strabismus), stereo vision is compromised (Henson & Williams, 1980; Rutstein & Eskridge, 1984).

Most of the photographs used in this experiment came from U.S. sources: the National Gallery of Art and the Smithsonian American Art Museum Photograph Archive; photographs were also obtained from magazines, books, and the Internet (see Table S1 in the Supplemental Material available online for a list of the artists and control subjects whose photographs were used). We did not discriminate between painters and sculptors or between abstract and figurative painters, because most artists work in a variety of media and begin their training with representational drawing. Photographs of U.S. congressmen who were age and gender matched with the artists were used as control subjects. Photographs included heads and upper torsos and were not systematically different between the artists and control subjects. Eighty-seven percent of the artist photographs and 86% of the control photographs showed the subject's full face, and 13% of the artist photographs and 14% of the control photographs showed three quarters of the subject's face. Seventy-five percent of the artists and 74% of the control subjects were looking directly at the camera, and the rest of the subjects were looking elsewhere.

The eyes of the artists and congressmen were cropped from the full photographs. These cropped images were randomly intermixed, and two observers blind to the photographic subject's identity quantified each subject's eye alignment. We fit templates of eye contour and pupil for each eye of the photographic subjects (dashed outlines in Fig. S1A in the Supplemental Material), and the observers measured the distance between each canthus and the pupil in each eye. Photographs were included in the experiment only if the two observers considered the eyes

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sufficiently visible to assess eye alignment (artists: n = 123; control subjects: n = 129). The two observers' measurements were correlated ($p < .0001$, analysis of variance; $\eta^2 = .88$; intraclass correlation coefficient = .75). Alignment was calculated as follows: $\{[(L_t - ½ \times L)/L] - [(R_n - ½ \times R)/R]\} \times 100\%$, where L, the left-eye width, equals the sum of the distance between the nasal canthus of the left eye and the left-eye pupil, L_n, and the distance between the temporal canthus of the left eye and the left-eye pupil, L_t. R, the right-eye width, was calculated as the sum of the corresponding measurements for the right eye, R_n and R_t (see the images of the eyes in Fig. 1b). A negative alignment value indicates exotropia (outward deviating eyes), a positive value indicates esotropia (crossed eyes), and zero indicates precisely aligned eyes.

Results

In Experiment 1, the art students showed lower stereo accuracy than the nonartist control subjects for all nonzero disparities ($p = 8 \times 10^{-5}$, paired t test), which indicates that the art students had poorer stereopsis than the nonartists (Fig. 1a). We attribute the peak in performance in the artist population at zero disparity to a default assumption that the stimulus was flat.

In Experiment 2, the eyes of established artists were misaligned more often than were the eyes of control subjects (Fig. 1b). In control subjects, the location of the iris within the eye and the light reflection relative to the pupil tended to be the same for the two eyes, which indicates that control subjects likely had normal stereopsis. (Fig. S1 in the Supplemental Material shows examples of various degrees of interocular misalignment in artists and control subjects.) The eyes of established artists, in contrast, were more often misaligned. Quantitative analysis of eye alignment showed that the distributions for both artists and control subjects were normal (Jarque-Bera hypothesis test, $p > .05$), and the average eye deviation for each population was slightly exotropic (artists: −2.7%, $p = 3 \times 10^{-6}$; control subjects: −1.8%, $p = 2 \times 10^{-4}$); these results are consistent with previously published measurements (Roberts & Rowland, 1978). However, eye alignment in the artist population had a higher variance than eye alignment in the control population (F test, $p = 2 \times 10^{-6}$), which indicates an increased rate of strabismus among the artists.

Discussion

Our results demonstrate that artists have poorer stereopsis on average than the general population. Of course, the majority of artists have perfectly aligned eyes, so poor eye alignment is not a necessary condition for artistic success. In addition, there are many people with strabismus who show no evidence of exceptional artistic talent. Art students also show a higher incidence of dyslexia than do students

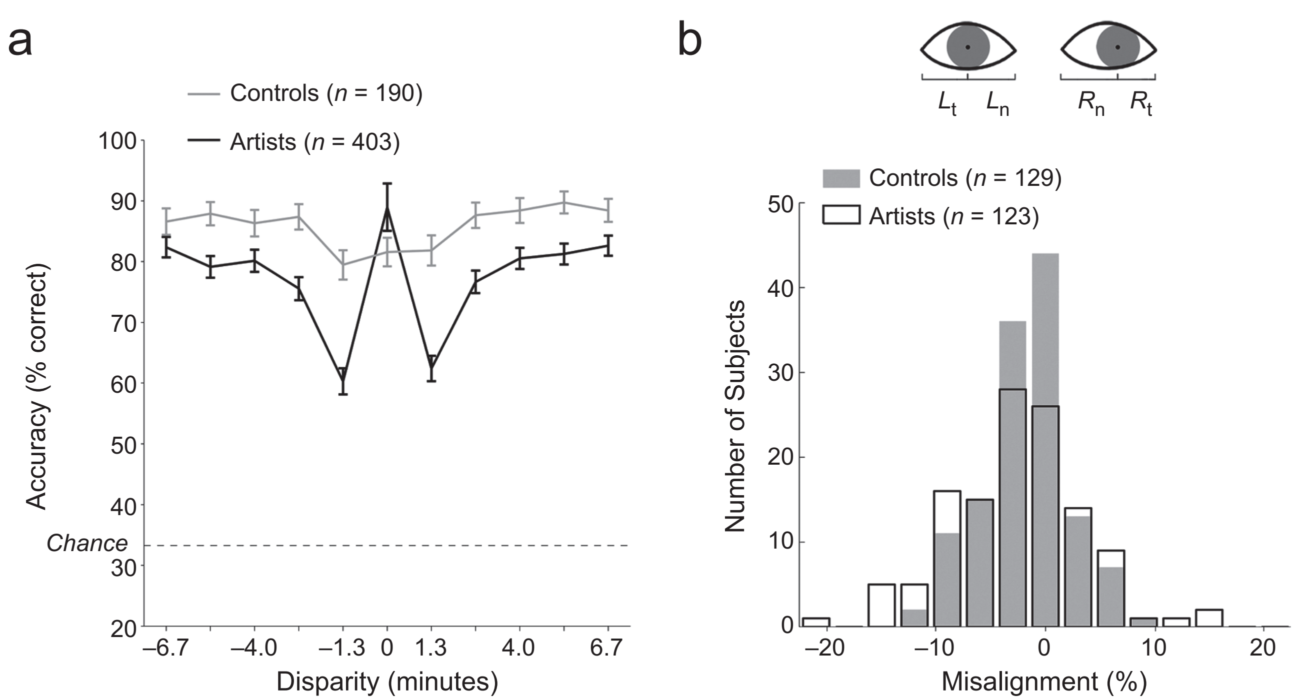

Fig. 1. Results from (a) Experiment 1 and (b) Experiment 2. The graph in (a) shows accuracy as a function of disparity of the stimuli for art students and nonartist control subjects. The dotted line indicates chance performance, and error bars represent standard errors of the population averages. The graph in (b) shows the distribution of values of eye misalignment as measured from photographs of established artists and nonartist control subjects. Interocular alignment was measured from the relative position of the irises within the two eyes in photographs of the subjects (top of graph; for an explanation, see the text).

who are not studying art (Wolff & Lundberg, 2002), and people with dyslexia show weaker binocular vergence than do control subjects (Buzzelli, 1991). One possible explanation for the correlation between stereopsis and artistic talent is that poor binocular vision interferes with reading skills and therefore encourages the pursuit of nonacademic activities, such as art. However, poor stereopsis might also be an asset to the artist because it makes monocular depth cues more salient. We favor this explanation for three reasons. First, the advantage of monocular viewing is well documented in art training. Second, the established artists we studied were exceptionally talented. And third, the strict admission criteria of the art schools in which we conducted our experiments makes it unlikely that these individuals were studying art simply as a compensation for poor academic skills. At a minimum, if poor stereopsis does not contribute to artistic talent, it certainly does not detract from it.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Supplemental Material

Additional supporting information may be found at http://pss.sagepub.com/content/by/supplemental-data

References

Buzzelli, A.R. (1991). Stereopsis, accommodative and vergence facility: Do they relate to dyslexia? *Optometry and Vision Science*, *68*, 842–846.

Henson, D.B., & Williams, D.E. (1980). Depth perception in strabismus. *British Journal of Ophthalmology*, *64*, 349–353.

Hirschberg, J. (1885). Uber die Messung des Schieldgrades und die Dosierung der Schieloperation. *Zentralblatt fur Praktisch Augenheilkunde*, *8*, 325–327.

Livingstone, M.S., & Conway, B.R. (2004). Was Rembrandt stereoblind? *New England Journal of Medicine*, *351*, 1264–1265.

Roberts, J., & Rowland, M. (1978). *Refractive status and motility defects of persons 4–74 years, United States 1971–1972. Vital and health statistics: Series 11* (DHEW Publication No. (PHS) 78-1654). Hyattsville, MD: National Center for Health Statistics.

Rutstein, R.P., & Eskridge, J.B. (1984). Stereopsis in small-angle strabismus. *American Journal of Optometry & Physiological Optics*, *61*, 491–498.

Wolff, U., & Lundberg, I. (2002). The prevalence of dyslexia among art students. *Dyslexia*, *8*, 34–42.