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Cerebral visual impairment: Dorsal stream vulnerability from amblyopia and autism to attention

Advances in assessing sensory and cognitive vision in infants and young children have enabled us to establish milestones of visual development and provide means for identifying visual disorders at an early age. These include novel EEG and behavioural techniques and tests such as Cambridge Crowding cards, the first child-friendly preschool crowded acuity test for identifying amblyopia, and photo- and video refraction (VPR1), for rapid identification of refractive errors at any age. Using these new techniques, in our population RCT refractive screening programs of over 8000 infants, we demonstrated that refractive correction with glasses in infancy could successfully reduce the incidence of strabismus and amblyopia. However, many children who had been significantly hyperopic in infancy showed mild pre-school visuomotor and attentional deficits. Combined with similar deficits in neurodevelopmental disorders, this led us to devise measures of development of the cortical dorsal stream, underpinning motion sensitivity, visuomotor control of actions and eye movements, and the ventral stream, underpinning orientation, shape, and object/face perception. The ball in the grass test compares motion sensitivity (dorsal) with static form sensitivity (ventral). We found deficits in motion sensitivity in children with Williams syndrome, autism, very preterm birth, perinatal brain injury and hemiplegia. This dorsal stream vulnerability (DSV) has now been found in many disorders, both genetic and acquired, including amblyopia. Besides poor motion sensitivity, it includes deficits in visuomotor control and visual attention. From MRI, we find that children's individual differences in motion sensitivity are correlated with specific areas of growth in parietal cortex, the integrity of the superior longitudinal fasciculus (major fibre tract connecting frontal with parietal areas) and visuomotor and mathematical ability. This suggests that motion sensitivity relates to higher-order decision-making and visual attention, and may provide useful early diagnostic indicators of visuo-cognitive deficits in amblyopia, cerebral visual impairment and genetic retinal dystrophies.

Recent Publications

1. J Atkinson, O Braddick O, W Bobier, S Anker, D Ehrlich, J King, P G Watson and A T Moore (1996) Two infant vision screening programmes: prediction and prevention of strabismus and amblyopia from photo- and video-refractive screening. Eye 10:189-198.
2. Atkinson J, Braddick O, Nardini M and Anker S (2007) Infant hyperopia: detection, distribution, changes and correlates-outcomes from the Cambridge infant screening programs. Optometry & Vision Science 84(2):84-96.
3. Atkinson J and Braddick O (2012) Visual attention in the first years: typical development and developmental disorders. Devel Med Child Neurol 54:589–595.
4. Braddick O, Atkinson J, Newman E, Akshoomoff N, Kuperman J M, Bartsch H, Chi-Hua Chen C-H, Dale A and Jernigan T L (2016) Global visual motion sensitivity: associations with parietal area and children's mathematical cognition. Journal of Cognitive Neuroscience 78:1897-190.
5. Atkinson J (2017) Visual brain development: a review of "dorsal stream vulnerability"—motion, mathematics, amblyopia, actions, and attention. Journal of Vision 17(3):1–24.

Biography

Janette Atkinson is an internationally renowned pioneer in research on normal and abnormal visual development in infants and young children, directing Visual Development Unit at Cambridge University, UCL London University and Oxford University. Together with collaborators in ophthalmology, visual neuroscience, optometry and pediatric neurology, she has broken new ground in devising novel visual tests and techniques to understand visual brain development and used these findings to assess and remediate visual impairment. She has over 150 peer-reviewed publications in leading international journals. She has been honored by election to fellowships of the Academy of Medical Sciences, Academia Europaea, and the British Academy and awarded Kurt Koffka Medal of Giessen University for research in visual science. In addition, she was awarded Davida Teller Award of Vision Sciences Society in 2016 for her outstanding contribution to vision research.

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