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Lateral thinking – Interocular symmetry and asymmetry in neurovascular patterning, in health and disease

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ABSTRACT

No biological system or structure is likely to be perfectly symmetrical, or have identical right and left forms. This review explores the evidence for eye and visual pathway asymmetry, in health and in disease, and attempts to provide guidance for those studying the structure and function of the visual system, where recognition of symmetry or asymmetry may be essential.

The principal question with regards to asymmetry is not 'are the eyes the same?', for some degree of asymmetry is pervasive, but 'when are they importantly different?'. Knowing if right and left eyes are 'importantly different' could have significant consequences for deciding whether right or left eyes are included in an analysis or for examining the association between a phenotype and ocular parameter. The presence of significant asymmetry would also have important implications for the design of normative databases of retinal and optic nerve metrics.

In this review, we highlight not only the universal presence of asymmetry, but provide evidence that some elements of the visual system are inherently more asymmetric than others, pointing to the need for improved normative data to explain sources of asymmetry and their impact on determining associations with genetic, environmental or health-related factors and ultimately in clinical practice.

Contents

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List of abbreviations

ALKB	alkylated DNA repair protein B
ARMD	age-related macular degeneration
AVR	arteriole-to-venule ratio
BMO	Bruch's membrane opening
BMP	bone morphogenetic protein
BOLD-MRI	blood oxygenation level dependent magnetic resonance imaging
CCA	common carotid artery
CI	confidence interval
cpRNFL	circumpapillary retinal nerve fibre layer
CRAE	central retinal arteriolar equivalent
CRVE	central retinal venular equivalent
CNV	choroidal neovascular membrane
CT	computed tomography
Cyc	cyclops
DOA	Autosomal dominant optic atrophy
ENU	N-ethyl-N-nitrosourea
GA	geographic atrophy
GCC	ganglion cell complex
GCL	ganglion cell layer
GC-IPL	ganglion cell and inner plexiform layer
HRT	Heidelberg Retina Tomograph
ICA	internal carotid artery
ICC	intraclass correlation coefficient
INL	inner nuclear layer
IOP	intraocular pressure
LGN	lateral geniculate nucleus
LHON	Leber hereditary optic neuropathy
MRI	magnetic resonance imaging
MS	multiple sclerosis
OCT	optical coherence tomography
Oep	one-eyed pinhead
ONSD	optic nerve sheath diameter
OTX	orthodenticle homeobox
Pax	paired box protein
PCA	posterior cerebral artery
Pitx	paired-like homeodomain transcription factor
PPAA	posterior pole asymmetry analysis
Ptdsr	phosphatidylserine receptor
RAPD	relative afferent pupillary defect
RGC	retinal ganglion cell
RNFL	retinal nerve fibre layer
RP	retinitis pigmentosa
RRD	rhegmatogenous retinal detachment
SD-OCT	spectral-domain optical coherence tomography
SLO	scanning laser ophthalmoscope
Sox	SRY-Box transcription factor
TBX	T-box transcription factor
TCD	transcranial Doppler ultrasonography
TD-OCT	time-domain optical coherence tomography
TGFβ	transforming growth factor β
TMX	thioredoxin-related transmembrane protein
USH2A	usherin gene
VAMPIRE	vessel assessment and measurement platform for images of the retina
WMH	white matter hyperintensities
Wnt	wingless-related integration site

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