SPECIAL ISSUE: ORIGINAL ARTICLE

HEREDITARY PROSOPAGNOSIA: THE FIRST CASE SERIES

Martina Grueter[1], Thomas Grueter[2], Vaughan Bell[3], Juergen Horst[1], Wolfgang Laskowski[4], Karl Sperling[5], Peter W. Halligan[3], Hadyn D. Ellis[3] and Ingo Kennerknecht[1]

([1]Institute of Human Genetics, Westfälische Wilhelms-University, Münster, Germany; [2]Faculty of Psychology, Department of Psychological Basic Research, University of Vienna, Liebiggasse 5, Vienna, Austria; [3]School of Psychology, Cardiff University, Cardiff, UK; [4]Atrium 7, Linsengericht, Germany; [5]Institute of Human Genetics, Charité, Berlin, Germany)

Abstract

Prosopagnosia is defined as a specific type of visual agnosia characterised by a discernible impairment in the capacity to recognise familiar people by their faces. We present seven family pedigrees with 38 cases in two to four generations of suspected hereditary prosopagnosia, detected using a screening questionnaire. Men and women are impaired and the anomaly is regularly transmitted from generation to generation in all pedigrees studied. Segregation is best explained by a simple autosomal dominant mode of inheritance, suggesting that loss of human face recognition can occur by the mutation of a single gene. Eight of the 38 affected persons were tested on the Warrington Recognition Memory Test for Faces (RMF; Warrington, 1984), famous and family faces tests, learning tests for internal and external facial features and a measure of mental imagery for face and non-face images. As a group, the eight participants scored significantly below an age- and education-matched comparison group on the most relevant test of face recognition; and all were impaired on at least one of the tests. The results provide compelling evidence for significant genetic contribution to face recognition skills and contribute to the promise offered by the emerging field of cognitive neurogenetics.

Key words: prosopagnosia, face recognition, agnosia, congenital prosopagnosia, hereditary prosopagnosia

Introduction

First named by Bodamer (1947; see Ellis and Florence, 1990), prosopagnosia refers to a specific type of visual agnosia in which there is an impairment in recognising familiar people by their faces. Although traditionally associated with brain injury acquired in later life, a small number of reports of "developmental prosopagnosia" or "congenital prosopagnosia" have been published. These cases do not comprise a homogeneous group, however, and differ on a number of important variables, including aetiology, pathogenesis, the manner in which such cases came to clinical awareness and the type and extent of impairments.

Cases presented as "developmental prosopagnosia" can be classified into three main groups: (a) cases associated with early acquired brain injury (see Table I); (b) cases associated with concurrent neurodevelopmental disorders (e.g., Asperger syndrome; see Table II); and (c) cases not associated with early acquired brain defects or neurodevelopmental disorders (see Table III). This last group has also been described as congenital.

TABLE I

Cases of prosopagnosia associated with early acquired brain injury

Reference	Case	Age at testing	RMF	BFRT	FF% (controls)	Associated aetiology	Reported non-face impairments
Young and Ellis (1989)	K.D.	8-11	n/a	37/54	n/a	Meningococcal meningitis, hydrocephalus, and multiple operations (age 14 months to 4 years)	Spatial orientation and navigation, figure copying, object recognition, achromatopsia
de Gelder and Rouw (2000)	R.P.	49	32/50	31/54	"Severely impaired"	Closed head injury (age 6)	None reported
Barton et al. (2003)	G.A.	21	30/50	39/54	0 (n/a)	Cardiopulmonary arrest and coma (age 1)	Spatial orientation and navigation
	K.B.N.	31	23/50	39/54	n/a	Frequent seizures (since age 2)	Spatial orientation and navigation, reading difficulties
	K.T.	36	29/50	28/54	5.9 (n/a)	Respiratory arrest and vegetative state (age 6)	Spatial orientation and navigation, reading difficulties
Michelon and Biederman (2003)	M.J.H.	34	n/a	n/a	55 (97.5)	Traumatic brain injury leading to left visual cortex and right fusiform gyrus lesion (age 5)	Restricted visual field, comprehension of abstract drawings, mild learning disability, motor co-ordination, tics

Note. RMF = Warrington Recognition Memory Test for Faces, BFRT = Benton Facial Recognition Test, FF = famous faces test.

TABLE II
Cases of prosopagnosia associated with neurodevelopmental disorder

Reference	Case	Age at testing	RMF	BFRT	FF% (controls)	Associated aetiology	Reported non-face impairments
Kracke (1994)	H.D.	19	24/50	0/54	n/a	Asperger syndrome	Motor co-ordination
Ellis and Leafhead (1996)	Raymond	Late 30 sec	n/a	n/a	30 (91)	Asperger syndrome	Object recognition, visual memory, motor co-ordination
Cipolotti et al. (1999)	P.E.	29	23/50	40/54	n/a	Autism, Tourette syndrome, congenital deafness	Within-category discrimination (animals), tics
Njiokiktjien et al. (2001)	B	10	n/a	n/a	n/a	Asperger syndrome	Motor co-ordination, smell, gestalt perception, language (word finding, fluency, prosody), tactile perception on right
	C	6	n/a	n/a	n/a	Asperger syndrome	Motor co-ordination, tics
	D	8	n/a	n/a	n/a	Asperger syndrome	None reported
Duchaine et al. (2003a)	T.A.	42	n/a	n/a	12 (94)	Asperger syndrome	Object recognition
Pietz et al. (2003)	Unnamed	4	n/a	n/a	n/a	Asperger syndrome	Motor co-ordination

Note. RMF = Warrington Recognition Memory Test for Faces, BFRT = Benton Facial Recognition Test, FF = famous faces test.

Cases following childhood injury involve a diverse range of aetiologies, from complications of meningococcal meningitis, to seizure disorder and presumed anoxic injury (Table I). The majority of cases show other visuo-spatial impairments, particularly with spatial orientation and navigation. Cases with neurodevelopmental disorders (as outlined in Table II) all involve a diagnosis of Asperger syndrome, with the exception of case P.E. who had a diagnosis of concurrent autism, Gilles de la Tourette syndrome and congenital deafness. Many also had neuropsychological impairments typical of autism spectrum disorders (such as motor co-ordination difficulties); but four also report additional impairments in non-face visual perception.

Table III summarises cases of prosopagnosia not linked to acquired injury or other developmental disorders. Inclusion in this group was determined on the basis that subjects do not report any *other* developmental disorder. The majority of reports specifically exclude these factors, although in Kress and Daum's (2003a) study, patients S.O. and G.H. were described as "congenital prosopagnosics", despite there being no specific exclusion of other factors by the authors.

Previous classification of what was believed to be "early onset" prosopaganosia was confusing, given that some reviews used different criteria for inclusion in their studies. Barton et al. (2003) used a wide definition incorporating cases of early acquired injury, concurrent neurodevelopmental disorder and presumed hereditary cases without obvious brain pathology. Kress and Daum (2003b) specifically excluded any cases of brain damage during childhood, but still included the Kracke (1994) case with a diagnosis of Asperger syndrome. Different studies have also used

TABLE III
Assumed cases of hereditary prosopagnosia

Reference	Case	Age at testing	RMF	BFRT	FF% (controls)	Reported non-face impairments
McConachie (1976)	A.B.	12	n/a	n/a	n/a	Motor co-ordination, spatial orientation and navigation
de Haan and Campbell (1991)	A.B.	27	28/50	39/54	41 (96.9)	Object recognition, particularly within-category discrimination
Temple (1992)	Dr S	n/a	43/50	"Performed normally"	31 ('significantly poorer' than controls)	Spatial orientation and navigation, visual memory
Ariel and Sadeh (1996)	L.G.	8	n/a	4 (before test abandoned)	38 (n/a)*	Gestalt perception of letters, visual-motor integration, object recognition
Bentin et al. (1999)	Y.T.	36	32/50	41/54	3.6 (58)	None reported
Duchaine (2000)	B.C.	52	46/50	43/54	24 (94)	Central auditory processing, motor co-ordination
de Gelder and Rouw (2000)	A.V.	42	34/50	34/54	n/a	None reported
Jones and Tranel (2001)	T.A.	5	n/a	n/a	0 (96)*	Spatial orientation and navigation, visual perception and discrimination
Nunn et al. (2001)	E.P.	37	41/50	46/54	25 (90)	None reported
Kress and Daum (2003a)	S.O.	34	34/50	n/a	28 (93.5)	None reported
	G.H.	54	45/50	n/a	44 (93.5)	None reported
Duchaine et al. (2003b)	N.M.	40	26/50	n/a	60 (94)	Spatial orientation and navigation, within-category object recognition

Note. RMF = Warrington Recognition Memory Test for Faces, BFRT = Benton Facial Recognition Test, FF = famous faces test.
*Test was on pictures of familiar family members rather than famous people.