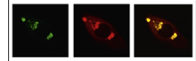


Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/brainres

Brain Research



Research Report

Distribution of calcium-binding proteins in the pigeon visual thalamic centers and related pretectal and mesencephalic nuclei. Phylogenetic and functional determinants

Margarita G. Belekhova^a, Tatiana V. Chudinova^a, Jean-Paul Rio^b,
H erve Tostivint^c, Nikolai P. Vesselkin^{a,d}, Natalia B. Kenigfest^{a,c,*}

^aLaboratory of Molecular Mechanisms of Neuronal Interactions, Sechenov Institute of Evolutionary Physiology and Biochemistry, Russian Academy of Sciences, 44, Thorez Avenue, 194223 Saint-Petersburg, Russia

^bCRICM UPMC/INSERM UMR_S975/CNRS UMR 7225, H opital de la Salp etri re, 47, Bd de l'H opital, 75651 Paris Cedex 13, France

^cCNRS UMR 7221, MNHN USM 0501, D epartement R egulations, D eveloppement et Diversit  Mol culaire du Mus um National d'Histoire Naturelle, 7, rue Cuvier, 75005 Paris, France

^dDepartment of Medicine, The State University of Saint-Petersburg, 7-9, Universitetskaya nab., 199034 St. Petersburg, Russia

ARTICLE INFO

Article history:

Accepted 22 November 2015

Available online 28 November 2015

ABSTRACT

Multichannel processing of environmental information constitutes a fundamental basis of functioning of sensory systems in the vertebrate brain. Two distinct parallel visual systems – the tectofugal and thalamofugal exist in all amniotes. The vertebrate central nervous

Abbreviations: Advr, anterior dorsal ventricular ridge; al, ansa lenticularis; CB, calbindin; CaBPrs, calcium-binding proteins; Ce, central subdivision of Rot; CO, cytochrome oxidase; Da, dorsal anterior subdivision of Rot; DIP, nucleus dorsointermedius posterior thalami; DLA, nucleus dorsolateralis anterior; DLAlr, DLA, pars rostrolateralis; DLAmc, DLA, pars magnocellularis; DLL, DLA, pars lateralis; DLLl, DLL, pars lateralis; DLLm, DLL, pars medialis; DLP, nucleus dorsolateralis posterior thalami; DMA, nucleus dorsomedialis anterior thalami; DMP, nucleus dorsomedialis posterior thalami; EM, nucleus ectomamillaris; GLd, nucleus geniculatus lateralis, pars dorsalis; GLv, nucleus geniculatus lateralis, pars ventralis; fpl, fasciculus prosencephali lateralis; IMc, nucleus isthmi, pars magnocellularis; IO, nucleus isthmoopticus; IPC, nucleus isthmi, pars parvocellularis; IPS, nucleus interstitio-pretectal-subpretectalis; LA, nucleus lateralis anterior; LdOPT, nucleus lateralis dorsalis of nuclei optici principalis thalami; LM, nucleus lentiformis mesencephali; LP/Pulv, nucleus lateralis posterior/pulvinar; MOT, nucleus marginalis tractus optici; nIV, nucleus nervi trochlearis; om, tractus occipitomesencephalicus; Ov, nucleus ovoidalis; PV, parvalbumin; PD, nucleus pretectalis diffusus; Po, posterior subdivision of Rot; PPC, nucleus principalis precommissuralis; pst, tractus pretectosubpretectalis; PT, nucleus pretectalis; Pv, nucleus posteroventralis thalami; Rot, nucleus rotundus; RS, nucleus reticularis superior; RSd, RS, pars dorsalis; RSv, RS, pars ventralis; SGC, stratum griseum centrale TeO; SGF, stratum griseum et fibrosum superficiale TeO; SLu, nucleus semilunaris; SP, nucleus subpretectalis; SPC, nucleus superficialis parvocellularis; SPL, nucleus spiriformis lateralis; SPM, nucleus spiriformis medialis; SpRot, nucleus suprarotundus; Str, striatum; tEM, tractus tectoeptomamillaris; TeO, tectum opticum; tio, tractus isthmoopticus; Tr, triangular subdivision of Rot; tro, tractus opticus; tsm, tractus septomesencephalicus; tt, tractus tectothalamicus; tti, tractus tectoisthmalis; VLT, nucleus ventrolateralis thalami

*Corresponding author at: CNRS UMR 7221, MNHN USM 0501, D epartement R egulations, D eveloppement et Diversit  Mol culaire du Mus um National d'Histoire Naturelle, 7, rue Cuvier, 75005 Paris, France. Fax: +33 1 40793618.

E-mail addresses: belekhova@yahoo.com (M.G. Belekhova), tvchudinova@gmail.com (T.V. Chudinova), jean-paul.rio@icm-institute.org (J.-P. Rio), herve.tostivint@mnhn.fr (H. Tostivint), npves@yahoo.com (N.P. Vesselkin), kenig51@yahoo.com (N.B. Kenigfest).

<http://dx.doi.org/10.1016/j.brainres.2015.11.037>

0006-8993/  2015 Elsevier B.V. All rights reserved.

Keywords:

Calcium-binding proteins
 Visual thalamic and related centers
 Immunohistochemistry
 Phylogeny and functional
 specialization
 Birds

system contains high concentrations of intracellular calcium-binding proteins (CaBPrs) and each of them has a restricted expression pattern in different brain regions and specific neuronal subpopulations. This study aimed at describing the patterns of distribution of parvalbumin (PV) and calbindin (CB) in the visual thalamic and mesencephalic centers of the pigeon (*Columba livia*). We used a combination of immunohistochemistry and double labeling immunofluorescent technique. Structures studied included the thalamic relay centers involved in the tectofugal (nucleus rotundus, Rot) and thalamofugal (nucleus geniculatus lateralis, pars dorsalis, GLd) visual pathways as well as pretectal, mesencephalic, isthmic and thalamic structures inducing the driver and/or modulatory action to the visual processing. We showed that neither of these proteins was unique to the Rot or GLd. The Rot contained i) numerous PV-immunoreactive (ir) neurons and a dense neuropil, and ii) a few CB-ir neurons mostly located in the anterior dorsal part and associated with a light neuropil. These latter neurons partially overlapped with the former and some of them colocalized both proteins. The distinct subnuclei of the GLd were also characterized by different patterns of distribution of CaBPrs. Some (nucleus dorsolateralis anterior, pars magnocellularis, DLAmc; pars lateralis, DLL; pars rostromedialis, DLAr; nucleus lateralis anterior thalami, LA) contained both CB- and PV-ir neurons in different proportions with a predominance of the former in the DLAmc and DLL. The nucleus lateralis dorsalis of nuclei optici principalis thalami only contained PV-ir neurons and a neuropil similar to the interstitial pretectal/thalamic nuclei of the tectothalamic tract, nucleus pretectalis and thalamic reticular nucleus. The overlapping distribution of PV and CB immunoreactivity was typical for the pretectal nucleus lentiformis mesencephali and the nucleus ectomillaris as well as for the visual isthmic nuclei. The findings are discussed in the light of the contributive role of the phylogenetic and functional factors determining the circuits' specificity of the different CaBPr types.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

Multichannel processing of environmental information constitutes a fundamental basis of functioning of sensory systems in the vertebrate brain (Livingstone and Hubel, 1988; Young, 1998; Born, 2001; Nassi and Callaway, 2009; Shimizu et al., 2010). Two distinct parallel visual systems – the tectofugal and thalamofugal exist in all amniotes (Butler and Hodos, 2005; Shimizu et al., 2010; Butler et al., 2011).

1.1. The tectofugal system (the visual thalamic relay nucleus rotundus)

The tectofugal system is the principal visual pathway in most avian species, playing a pivotal role in the visual information processing. Its thalamic relay nucleus, the nucleus rotundus (Rot) has no direct retinal afferents, receives visual information after relaying in the optic tectum and further projects to the telencephalic target entopallium (Karten, 1969; Benowitz and Karten, 1976; Shimizu and Karten, 1991; Hellmann and Güntürkün, 2001; Reiner et al., 2004, 2005; Wylie et al., 2009; Fredes et al., 2010; Shimizu et al., 2010). The avian Rot consists of several distinct subdivisions (dorsal anterior, Da; central, Ce; posterior, PO, and triangular, Tr) distinguished by discrete projections from different types of tectal and pretectal neurons, their individual projections upon the entopallium and by different roles in the discrimination of various visual flows (Benowitz and Karten, 1976; Mpodozis et al., 1996; Deng and Rogers, 1998; Hellmann and Güntürkün, 1999;

Becker and Redies, 2003; Marín et al., 2003; Fredes et al., 2010; Shimizu et al., 2010). Several authors have suggested that the avian tectofugal visual system is a homologous to the mammalian extrastriate visual system (colliculus superior – nucleus lateralis posterior/pulvinar (LP/Pulv) – extrastriate cortex (“neocortex hypothesis” Karten, 1969, 2013; Benowitz and Karten, 1976; Mpodozis et al., 1996; Karten et al., 1997; Deng and Rogers, 1998; Luksch et al., 1998; Hellmann and Güntürkün, 1999, 2001; Becker and Redies, 2003; Marín et al., 2003; Wylie et al., 2009; Fredes et al., 2010; Shimizu et al., 2010; Cook et al., 2013). However, on the basis of embryology, genetic, hodological and neurochemical findings, the sauropsid Rot is considered as a homologue of the intralaminar/some posterior nuclei in the mammalian thalamus, and its target in the Advr as a homologue of the claustror-amygdalar complex (“claustror-amygdalar hypothesis” Dávila et al., 2000, 2002; Puelles, 2001; Bruce et al., 2002; Guirado et al., 2005; Striedter, 2005; Bruce, 2007; Xi et al., 2008). The problem of the homology of the tectofugal visual system across amniotes remains unsolved.

1.2. The thalamofugal system (the visual relay thalamic nucleus geniculatus lateralis, pars dorsalis)

In the avian thalamofugal visual pathway, the thalamic nucleus geniculatus lateralis, pars dorsalis (GLd) - principal thalamic relay optic nucleus (OPT), according to Karten et al. (1973) receives a direct retinal projection and further projects to the hyperpallial posterior Wulst (Karten et al., 1973; Miceli

Download English Version:

<https://daneshyari.com/en/article/6262619>

Download Persian Version:

<https://daneshyari.com/article/6262619>

[Daneshyari.com](https://daneshyari.com)