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Research Report

Thalamo-striatal projections in the hedgehog tenrec

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ABSTRACT

Unlike the basal ganglia input from the midline and intralaminar nuclei, the origin and prominence of striatal projections arising in the lateral thalamus varies considerably among mammals being most restricted in the opossum and monkey, most extensive in the rat. To get further insight into the evolution of thalamo-striatal pathways the Madagascar lesser hedgehog tenrec (Afrotheria) was investigated using anterograde and retrograde flow techniques. An extensive medial thalamic region (including presumed equivalents to the paraventricular, parataenial and dorsomedial nuclei as well as the reuniens complex), the rostral (central) and caudal (parafascicular) intralaminar nuclei were shown to give rise to striatal projections. Additional projections originated in the ventral anterolateral nuclear group and regions within and around the medial geniculate complex. Similar to the rat there was also substantial projections from the lateral posterior–pulvinar complex and the ventral posterior nucleus. The fibers terminated extensively across the striatum in a mainly homogeneous fashion. Isolated patches of low-density terminations were found in the caudoputamen. This inhomogeneous labeling pattern appeared similar to one described in the cat with the unlabeled islands showing features of striosomes. The medial and intralaminar nuclei also projected heavily upon the olfactory tubercle. Differential innervation patterns were noted in the polymorphous layer, the deep and the superficial molecular layer.

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Abbreviations:
Acb, ncl. accumbens
BDA, biotinylated dextran amine
CeC, centralis complex (CeL/M, ncl. centralis lateralis/medialis)
CPu, caudate–putamen complex
DMT, dorsomedial thalamic region
Et, Echinops telfairi
GLD, dorsal lateral geniculate nucleus
GM, medial geniculate nucleus
Hb, habenula
Hip, hippocampus
IPf, interparafascicular region
LPP, lateralis posterior–pulvinar nuclear complex
PAG, periaqueductal gray
PCx, paleocortex
Pf, ncl. parafascicularis (L/M, lateral/medial portion)
PPf, perifascicular region
ReC, reuniens complex
RLv, rostrolateral thalamus, ventral portion
rfl, fasciculus retroflexus
SGL, supragenicuiate–limitans complex
Sm, ncl.submedius
SPf, subparafasciular region
Tu, olfactory tubercle (P/S, principal/seam region)
VAC, ventralis anterior complex
VP, ventralis posterior complex (L/M, lateral/medial subdivision)
WGA-HRP, wheat germ agglutinin conjugated to horseradish peroxidase.

1. Introduction

It is well established today that thalamo-striatal projections arise not only from the intralaminar and midline nuclei but also from nuclear groups of the lateral thalamus (Beckstead, 1984; Ledoux et al., 1985; Lin et al., 1984; Royce, 1978b; Smith and Parent, 1986; Veening et al., 1980). In mammals, the most extensive striatal input from lateral thalamic regions has been shown in the rat (Cheatwood et al., 2003; Erro et al., 2002), while in the monkey, its origin appears largely restricted to the nucleus ventralis anterolateralis (McFarland and Haber, 2001; Smith and Parent, 1986). These findings support the hypothesis arisen from investigations in non-mammals that species with limited thalamo-cortico-striatal projections have relatively prominent striatal projections from the lateral (specific) thalamic nuclei and conversely those with strong thalamo-cortico-striatal projections have weaker thalamo-striatal projections (Reiner et al., 1998; Smeets et al., 2000). The marsupial opossum with a thalamo-striatal output region essentially restricted to the medial geniculate complex (Hazlett and Bagley, 1983; Kudo et al., 1986), however, does not fit into this scheme.

To get further information about the variable involvement of lateral thalamic areas giving rise to striatal projections among mammals and gain insight into the differential patterns of termination within the striatum we analyzed subsequently the thalamo-striatal projections in the Madagascar hedgehog tenrec (Afrosoricidae), an eutherian species with one of the least differentiated forebrain among mammals (Stephan et al., 1991). This study continues previous investigations about the cortico-striatal projections in the same species (Künzle, 2005a,b).

2. Results

2.1. *Retrograde tracer studies*

The cases with tracer injections into the striatum were listed in Table 1. Three experimental groups might be distinguished: (i) the cases injected with tracer into the olfactory tubercle (Tu; injection site shown in Fig. 3A in (Künzle, 2005b)), (ii) the cases injected into the nucleus accumbens