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The Pulvinar Thalamic Nucleus of Non-Human Primates: Architectonic and Functional Subdivisions

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Chapter 7
Visual Topography of the Pulvinar Projection Zones

Injection of tritiated amino acids in V2 revealed topographically organized projections targeting the P1, P2, and P4 regions of the pulvinar. The topographic map in P1 was originally described by Gattass et al. (1978a) in the capuchin monkey and subsequently by Bender (1981) in the macaque monkey. According to these authors, P1 is located in the PI but also includes a small portion of the immediately adjacent PL. The peripheral visual field is represented anteriorly in the medial portion of PI, while the central visual field is represented more posteriorly in the medial portion of PL. The vertical meridian is represented on the lateral edge of the nucleus, while the horizontal meridian is represented obliquely from lateral to medial across the nucleus and tilted slightly downward. The upper field is represented ventrally, while the lower field is represented dorsally.

The P1 map resembles a first-order transformation of the visual field (Allman and Kaas 1971). In the macaque monkey, the lateral portion of P1 seems to follow the P2 organization. It contains a representation of the peripheral visual field, which is located in the anterior portion of the nucleus, and a representation of the central visual field, which is located in the posterior portion of PL (Bender 1981). P2 and P1 share the representation of the vertical meridian, while P2's horizontal meridian representation is a continuation of P1's, in a way that the foveal region is represented at the lateral border of the pulvinar. Thus, the P2 map resembles a second-order transformation of the visual field (Allman and Kaas 1971). Gattass et al. (1978a) described a topographically organized region in dorsal pulvinar that seems to be equivalent to the P4 field described by Adams et al. (2000). P4 has a complex topographic arrangement. The representation of the vertical meridian is located on the dorsal edge of P4, while the representation of the horizontal meridian exits the dorsal edge and divides P4 into dorsal and ventral portions. The representation of the upper visual field occupies the dorsal and anterior P4, while the representation of the lower visual field is located ventral and posterior, adjacent to the lower field representation of P2. The P4 map resembles a distorted first-order transformation of the visual field (Allman and Kaas 1971).

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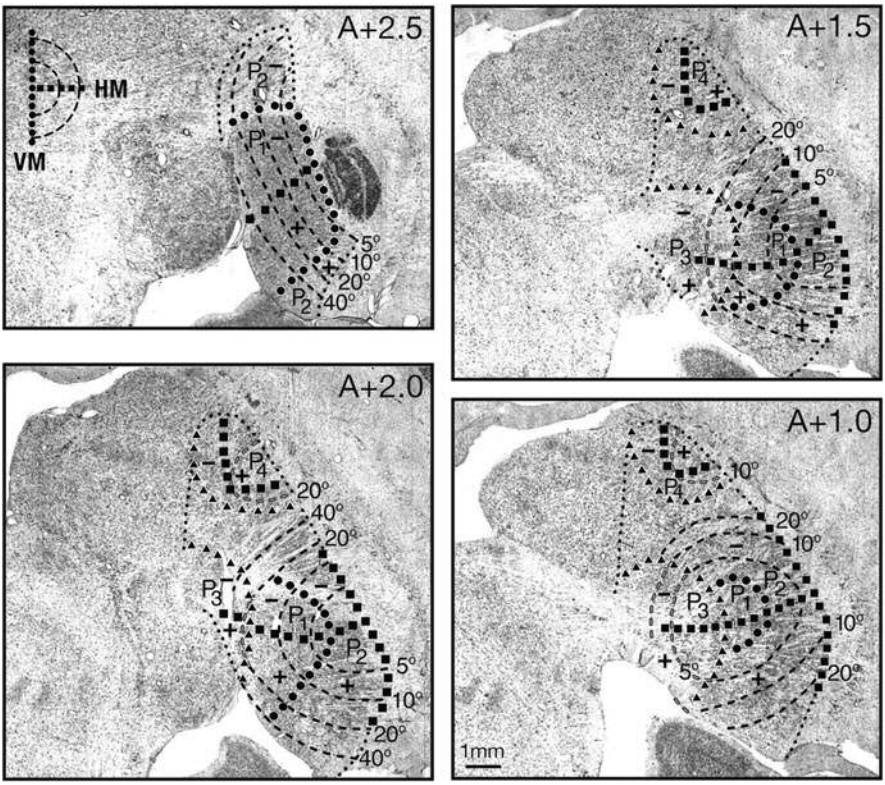

Fig. 7.1 Visual topography of the pulvinar P1, P2, P3, and P4 fields in the macaque monkey. Representative coronal sections stained for Nissl through the rostral (top left)-to-caudal (bottom right) extent of the pulvinar showing the visual topography of each of the four fields. The visual maps are shown superimposed on each section. Solid circles indicate the representation of the vertical meridian, solid squares indicate the representation of the horizontal meridian, heavy dashes indicate isoeccentricity lines, gray colored dashes indicate isoeccentricity lines in areas of coarse topography, small solid triangles indicate the borders of P3 and P4, and small dotted lines indicate the borders of the pulvinar fields. The plus sign indicates the upper visual field representation and the minus sign indicates the lower visual field representation. The sections are spaced 0.5 mm apart, and they do not reach the caudal extent of the pulvinar. Abbreviations as in Fig. 2.1. Scale bars = 1 mm. (Modified from Gattass et al. 2014)

Figure 7.1 shows the visuotopic maps of the macaque monkey pulvinar (P1–P4) charted onto Nissl-stained sections. The P1 and P2 maps are based on the work by Bender (1981) and Ungerleider et al. (1983, 1984). The estimate of P3's borders was guided by the work of Ungerleider et al. (1984) and Gattass et al. (2014). The dorsal border of P3 (i.e., the portion above the brachium of the SC) was adjusted to be compatible with the distribution of calbindin immunoreactive neurons presented in previous work (Adams et al. 2000; Gattass et al. 2014). The estimate of P4's border was also guided by the works of Adams et al. (2000) and Gattass et al. (2014).

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