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Dorsal Root Ganglion Neurons: Electrical Properties and Cell Type

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6. Dorsal root ganglion neurons: electrical properties and cell type

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It has been shown that there are two main morphological neuronal types in rat and mouse dorsal root ganglia (d.r.g.s), the large light (l.l.) and small dark (s.d.) neurons. Each population has a normally distributed range of cell sizes with different means, and the size ranges of the two populations overlap (Lawson 1979; Lawson & Harper, in press).

To examine the relationships between the electrophysiological characteristics and the morphological cell types of these neurons, intracellular recordings and dye injection were made in individual neuronal somata in L4 d.r.g.s of anaesthetized rats. The methods of preparation, recording and morphological analysis were as described previously (Harper & Lawson 1982; Lawson & Harper 1984).

Neurons were classified as Aα, Aβ, Aδ and C according to the conduction velocity of their peripheral axons in the sciatic–d.r.g. nerve length. Somatic action potential characteristics, input resistance and mean cell size of each of these groupings are given in table 1.

Table 1. Action potential parameters (duration at base, overshoot and the presence or absence of a hump on the falling phase), input resistance and mean ± S.D. of the somata size for each of the conduction velocity groupings

(The probable morphological cell type of the groups is also listed. Numbers in brackets refer to the number of cells for which values were obtained.)

c.v. m s^{-1}	properties	mean values		cell size	probable cell type
14–55 (Aα+β)	fast AP/no hump	1 ms at base	(42)	1141 ± 366 μm² (45)	large light
	overshoot	21 mV	(42)		
	low point impedance	11 MΩ	(29)		
14–30 (Aβ)	slower AP/hump	1.7 ms at base	(12)		
	greater overshoot	31 mV	(12)		
	low input impedance	7 MΩ	(12)		
less than 1.4 (C)	slow AP/hump	5 ms at base	(5)	449 ± 148 μm² (11)	small dark
	greater overshoot	32 mV	(5)		
	greater input impedance	37 MΩ	(6)		
2.2–8 (Aδ)	fast AP/no hump	0.9 ms at base	(11)	702 ± 448 μm² (9)	?
	overshoot	25 mV	(11)		
	low input impedance	15 MΩ	(4)		

The size range of the Aα+β and C groupings correspond very closely with those of the l.l. and s.d. populations respectively. The mean size and range of the Aδ neurons fall between the values for l.l. and s.d. cell populations, while their electrical properties are similar to the Aα neurons.

The present results demonstrate that correlations can be made between morphological cell type and the electrical properties of the axon and soma membranes of these neurons.

References

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7. Dichotomizing peripheral afferent fibres: a possible basis for referred pain

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Two mechanisms have been proposed to underlie the convergence–projection hypothesis for the referral of pain from visceral to somatic structures. Although spinal convergence would appear to explain the somato–visceral convergence reported by Cervero (this volume), there is physiological and morphological evidence to support pre-spinal convergence (Adrian *et al.* 1931; Lewis 1942). In intracellular recordings from neurons in the lumbar dorsal root ganglia (d.r.g.) of urethane anaesthetized rats, we have been able to study single d.r.g. neurons that responded to electrical stimulation of two or more branches of the sciatic nerve. There are three main findings. (1) Cooling of the different branches of the peripheral nerve showed that the convergence was due to propagated action potentials and not current spread. (2) Depolarization of the cell soma produced action potentials which were transmitted antidromically and collided with the orthodromic action potentials due to peripheral nerve stimuli. This excludes synaptic transmission as the cause of the phenomenon. (3) It appears that action potentials produced by stimulation of one nerve branch cannot necessarily be transmitted into the other branch.

In parallel with the above studies we have employed fluorescent tracers in double-labelling experiments to demonstrate the branching of peripheral afferent fibres (Taylor *et al.* 1983) in cats, rats and pigeons. These results extend those of Langford & Coggeshall (1981) and indicate the branching of peripheral afferent fibres to be a widespread phenomenon. There is therefore both physiological and morphological evidence for dichotomizing peripheral afferent fibres which could, at least in part, explain the phenomenon of referred pain.

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