Reflexes in Postganglionic Fibres within Skin and Muscle Nerves After Mechanical Non-Noxious Stimulation of Skin*

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Summary. 1. Somato-sympathetic reflexes in postganglionic neurones to hairy skin and to muscle produced by mechanical non-noxious stimulation of skin were studied in cats anesthetized with chloralose. Most of the postganglionic fibres investigated were spontaneously active and had presumably vasoconstrictor function.

2. In 60% of the cutaneous postganglionic neurones stimulation of hairs induced predominantly excitation. This excitation was mostly followed by a slight depression of the spontaneous activity. In 30% of the neurones the spontaneous activity was depressed or predominantly depressed by these stimuli.

3. In most muscle postganglionic neurones the spontaneous activity was depressed by stimulation of hairs.

4. In both types of neurones the reflexes were produced by activity in hair follicle receptors with Group II afferents. Hair follicle receptors with Group III afferents most probably also contributed to this effect. Except for a slight depression of the spontaneous activity in some cutaneous postganglionic neurones by slowly adapting receptors, mechanical stimulation of other types of receptors with Group II afferents had no effect on the postganglionic neurones.

5. Reflexes in postganglionic neurones could be elicited by stimulation of hairy skin all over the body surfaces.

Key words: Somato-sympathetic reflexes — Postganglionic fibres to skin and muscle — Natural stimulation of skin — Hair-follicle receptors — Cat

It has been known for a long time that electrical stimulation of cutaneous afferent fibres induces powerful reflexes in the sympathetic nervous system (Ranson, 1921; Koizumi and Brooks, 1972; Sato and Schmidt, 1973). These reflexes were determined mostly by recording the activity in pre- and postganglionic nerves and fibres or by recording autonomic effector responses themselves, for example blood pressure or sweat gland activity.

Electrical stimulation of all groups of cutaneous afferent fibres elicits reflex discharges in sympathetic neurones. The reflex discharges upon stimulation of myelinated afferents are followed by a depression of the spontaneous activity (for literature see Koizumi and Brooks, 1972; Sato and Schmidt, 1973). Stimulation

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of unmyelinated afferent fibres also elicits depression of spontaneous activity in cutaneous postganglionic fibres (Jänig et al., 1972).

Up to now in most investigations the somato-sympathetic reflexes were recorded from nerves which contain several functionally different types of sympathetic fibres. Furthermore, the electrical stimulation of the cutaneous afferent fibre groups left unsettled which types of cutaneous receptors are involved in the sympathetic reflexes. Therefore, a better understanding of these reflexes for the integrative activity of the sympathetic nervous system demands further work which reveals the types of cutaneous receptors responsible for initiating these reflexes and in which the type of sympathetic neurone recorded from is better specified.

In this and the following paper (Horeyseck and Jänig, 1974) experiments will be reported in which somato-sympathetic reflexes were elicited by natural stimulation of cutaneous receptors. The reflexes were recorded from two types of postganglionic fibres namely those in skin and muscle nerves which were specified as having most probably a vasoconstrictor function. The first paper deals with reflexes induced by mechanical non-noxious stimulation of skin. It will be shown that the afferent fibres involved in these reflexes derive mainly from hairs, that the reflexes can be elicited from all over the body surface, and that there must be a distinct organization of these reflexes in the neuraxis. A preliminary communication has appeared (Horeyseck and Jänig, 1971).

Methods

The experiments were performed on 24 adult cats (weight 2.4 to 4.8 kg). They were anesthetized with chloralose (18 with 70 mg/kg i.p., 6 with 60 mg/kg i.p.). All animals were immobilized by i.v. injections of gallamine triethiodide (Flaxedil). The artificial respiration was adjusted to provide an end-expiratory CO₂ of 3%. The mean blood pressure of the animals was continuously recorded and kept above 100 mm Hg, if necessary by infusion of dextran solution (Macrodex). The rectal temperature was kept at 37—38 °C. The vagal and depressor nerves as well as the carotid sinus nerves were cut bilaterally in order to eliminate effects from the peripheral baroreceptors.

Filaments with one to three postganglionic axons were dissected from the superficial peroneal nerve and the nerve to the lateral gastrocnemius muscle in a hind limb pool filled with mineral oil. A few cutaneous postganglionic fibres were also dissected from the sural nerve. For identification of the axons as sympathetic the lumbar sympathetic trunk (LST) was dissected free between L_4 and L_5 in a second oil pool using a retroperitoneal approach. The trunk was put onto a pair of platinum electrodes and stimulated with 1 to 3 volts for pulses of 0.2 msec duration. The postganglionic neurones were further specified by testing their response to repetitive stimulation of the vago-depressor nerve. For this purpose the vagal nerve was dissected free about 40 mm caudal to the nodose ganglion and put onto a pair of platinum electrodes. The electrodes and the nerve were covered with cotton soaked in mineral oil.

To stimulate functionally different types of cutaneous afferent fibres selectively, or nearly selectively, mechano-receptors of the skin were excited with different methods. Hairs with Group II and Group III afferent fibres (Brown and Iggo, 1967; Burgess et al., 1968) were stimulated by air jets of 200 to 500 msec duration. The air coming from a pressure tank was controlled by an electromagnetic valve and was blown through a nozzle of about 3 mm diameter onto the skin. The air jets were orientated tangentially to the skin of the body surface. In this way as many hairs as possible on areas of about 4 cm² to 20 cm² could be stimulated. Stimuli of constant force were applied to the central pad of the hind foot, resulting in excitation of Group II afferent fibres from slowly adapting receptors in the skin of the pad (Jänig et al., 1968). Rapidly adapting receptors in the dermis of the pad and Pacinian corpuscles in the subcutaneous fat of the pad were excited by sinusoidal stimuli of 20 to 30 Hz and of 100 to