Summary

Chapter 7

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This thesis is based upon four neurophysiological investigations on central aspects of jaw-motor control and a technique for the construction of a new cuff electrode for small nerves. The experiments were performed at the Department of Neurobiology and Oral Physiology of the State University of Groningen. The research at this department focuses on the formulation of a numerical model of the mandible-hyoid system relating morphological, mechanical, physiological and psychophysical parameters. This multidisciplinary approach towards the understanding of jaw-motor control is expected to give better insight in the contribution of these parameters to the function of the mandible-hyoid system as a whole. This thesis is a neurophysiological/neuroanatomical contribution to this research project.

We studied the influence of interneurons of various areas of the medulla oblongata upon first order trigeminal muscle spindle and periodontal afferents, and upon the final common path of the trigeminal and facial nerve.

Chapter 1 is an introduction to the thesis. It comprises a description of basic elements of motor control, the morphology and physiology of the oral musculature, and of the trigeminal and facial nerve insofar as necessary for a good understanding of this thesis.

Chapter 2 reports on the contribution of interneurons of the supratrigeminal area to the inhibition of jaw-closing motoneurons. It was investigated: 1) how sensory information from the inferior alveolar nerve -and from signals of low threshold periodontal mechanoreceptors in particular- is relayed by different interneurons in the supratrigeminal area, and 2) whether the different interneurons have different influences upon motoneurons of the jaw and facial musculature.

Intracellular recordings of interneurons in the supratrigeminal area showed two types of interneurons responding to graded stimulation of the inferior alveolar nerve. The interneurons were characterized on the basis of their firing characteristics. It appeared that the identified interneurons were elements of a disynaptic reflex arc which inhibit the motoneurons of the trigeminal and facial nerve. This inhibition of motoneurons is mainly attributed to low threshold periodontal receptors since maximal inhibition of the motoneurons was already achieved amply before a jaw-opening reflex was evoked by activation of high threshold periodontal afferents. It is speculated that the described reflex arc services a system of quick regulation of bite force. Since the jaw-closing muscles are much stronger than the jaw-opening muscles, a jaw-opening reflex (mainly triggered by high threshold periodontal receptors activated by biting on hard food
particles) can only be effective when jaw-closing motoneurons are inhibited simultaneously. The results described in the Chapters 2 and 3 suggest that during chewing jaw-closing motoneurons receive simultaneously an inhibitory (from low threshold periodontal mechanoreceptors) and an excitatory drive (from muscle spindles as well as from higher centres) that result in a net excitation of the motoneurons. This phenomenon probably is part of a protective system dealing with sudden occurring high biting forces. High biting forces in turn silence the central pattern generator for chewing (by the stimulated high threshold exteroceptors and periodontal receptors). This results in a drop of the excitatory drive on the motoneuron which leaves them hyperpolarized by the long lasting plateau of inhibition elicited by the periodontal receptors. Then the mouth is opened by the jaw-opening reflex evoked by high threshold primary afferent activity of the periodontium and oral exteroceptors; the subject of Chapter 3.

In this view the relative long latency of the jaw-opening reflex has its functional significance. This latency is caused by intrinsic properties of excitatory interneurons that are found in the mesencephalic trigeminal area and which project to the motoneurons of the jaw-opening muscles. When stimulated these interneurons respond with a slowly developing excitatory postsynaptic potential generating an action potential several milliseconds after its onset. This inherent delay causes the occurrence of the jaw-opening reflex to coincide with the period of maximal inhibition of jaw-closing motoneurons.

Physiological evidence is presented in Chapter 4 for the existence of commissural connections between the left and right trigeminal motor nucleus of the rat; interneurons in the trigeminal motor nucleus project directly to the contralateral trigeminal motor nucleus. Electrical stimulation of these commissural fibres evoked small amplitude inhibitory postsynaptic potentials in the jaw-closing motoneurons. Under these circumstances no postsynaptic potentials were recorded in jaw-opening motoneurons. Electrical stimulation of the commissural fibres also left the fusimotoneurons, the jaw-closing and opening reflex unaffected. Electromyographic recordings in the unrestrained rat showed that only jaw-closing muscles (masseter) were inhibited by stimulation of the commissural fibers, which is in accordance with the intracellular recordings. Possibly the investigated trigeminal reciprocal connections serve the coordination of bilateral activity of the jaw-closing muscles during unilateral chewing.

Chapter 5 describes the morphology and physiology of projections of the parvocellular reticular nucleus (PCr) to the contralateral mesencephalic trigeminal nucleus. The experiments showed that electrical stimulation of the PCr facilitates jaw-opening and jaw-closing reflexes, as well as muscle spindle activity. However, no postsynaptic events were recorded from the cell bodies of periodontal afferents, muscle spindle afferents (both in the trigeminal mesencephalic nucleus) and of interneurons in the supratrigeminal area following stimulation of the PCr. Possibly the PCr affects muscle spindle activity and jaw reflexes presynaptically or postsynaptically at the level of the trigeminal motor nucleus. This leaves the function of the PCr projection to the ventrocaudal part of the trigeminal mesencephalic nucleus obscure. Perhaps these projections are involved in throphic...
mechanisms, or do they adjust the sensibility of the mesencephalic trigeminal sensory system.

Chapter 6 describes a new bipolar strap-electrode for the stimulation and recording of small, difficult to reach, nerves of various diameters. The electrode is easy to build and has stable electrical and mechanical properties so that it is suitable for long lasting experiments.