SCANNING ELECTRON MICROSCOPIC STUDY OF LINGUAL CHEMORECEPTOR AND MECHANORECEPTOR FORMATION IN ANIMALS BORN IN A STATE OF MATURITY

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Maturation of the accessory structures of the different receptors of the dorsal surface of the tongue was shown previously not to be synchronized in mammals born in an immature state and in man [2, 3]. The times of formation of populations of lingual receptor structures during postnatal ontogeny have been shown to depend on the mode of feeding of the animal. In mammals born in an immature state and in man tactile and chemoreceptor papillae in the part of the tongue without which the chain of reactions responsible for the process of lactotrophic nutrition would be impossible have been observed to develop first. This active part of the tongue in the lactotrophic period has been shown to be the dorsal surface of the body of the tongue and its root.

The young of animals born mature, such as guinea pigs, while feeding on their mothers' milk, during the first few days after birth begin to display an interest in the food of adult animals, and this is reflected in attempts to grab food, to taste it, and to eat it.

It is therefore important to study differences in the times and dynamics of formation of the various receptor structures of the tongue in these animals. In the investigate described below the method of scanning electron microscopy was used because it enables whole populations of tactile and chemosensory papillae on comparatively large receptor-bearing surfaces to be examined. The times of maturation of the chemosensory papillae were determined from the time of appearance of pores in these structures, enabling contact between chemoreceptors and the taste stimulus, and the appearance of outgrowths in these papillae, i.e., their receptive surfaces, have served as a sign of the formation of the different kinds of tactile papillae, which have so far been studied comparatively poorly [4, 6]. Chemoreceptors and mechanoreceptors of the tongue at different age periods were compared with the lingual papillae of the adult animal, whose structure and topography were studied previously [1].

EXPERIMENTAL METHOD

The dorsal surface of the tongue in young guinea pigs, lambs, and goats at different ages (under two months) was studied. The tongues were washed for 20 min in running water, followed by distilled water, and fixed in 4% formalin solution or 2.5% glutaraldehyde solution (depending on age). Subsequent processing of the material was carried out by the method described previously [2, 3].

Different parts of the dorsal surface of the tongue were studied under Stereoscan-2A and σSM-50A scanning electron microscope.

EXPERIMENTAL RESULTS

At least one taste pore is present in the chemosensory papillae on the anterior free surface of the tongue of the newborn guinea pig (Fig. 1b). It is not yet raised above the surface of the papilla, as it is later in these animals (Fig. 1f, h), for by the third day

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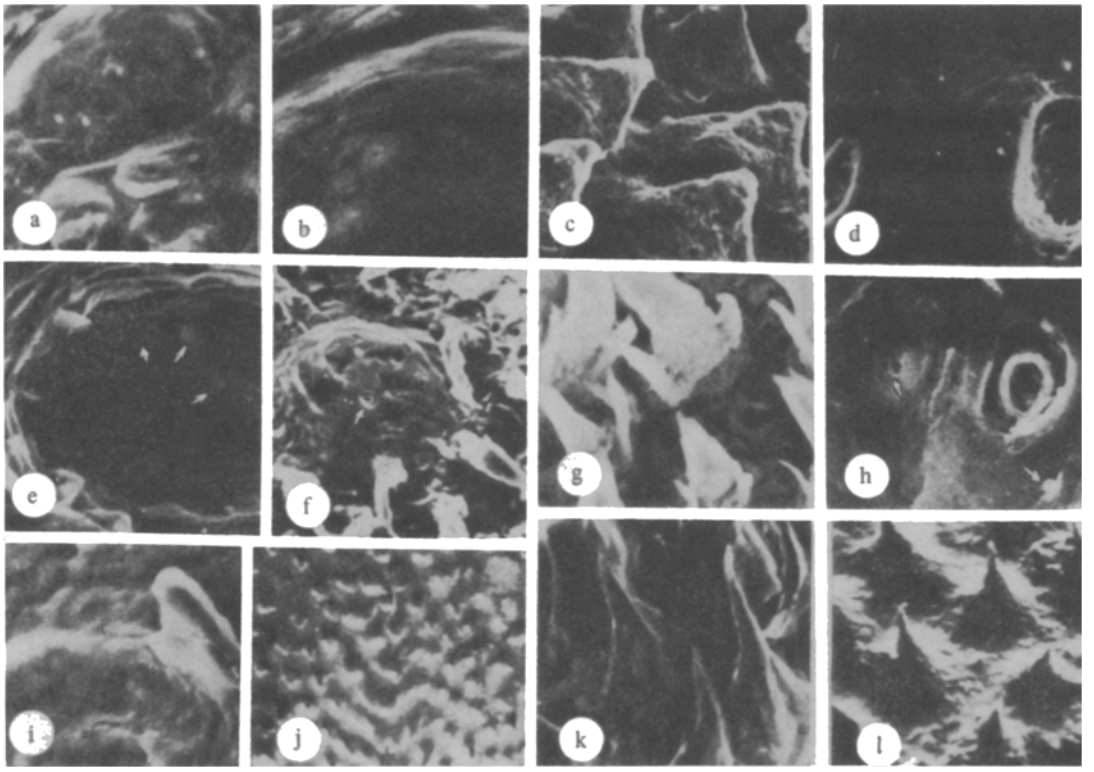

Fig. 1. Formation of chemoreceptor and mechanoreceptor structures in the guinea pig tongue. a) Fungiform papilla on tip of tongue of 50-day fetus, 500 ×; b) pore of fungiform papilla on tip of tongue of newborn guinea pig, 1000 ×; c) papillae on medial part of body of tongue of newborn guinea pig, 1500 ×; d) circumvallate papillae of newborn guinea pig, 180 ×; e) pores (arrow) on taste bulbs of circumvallate papilla of newborn guinea pig, 600 ×; f) fungiform papilla of 3-day guinea pig (pores indicated by arrows), 150 ×; g) filiform papillae of 3-day guinea pig, 200 ×; h) pores of fungiform papilla on body of tongue of 3-day guinea pig (the largest pore, indicated by an arrow, is in the center of the papilla), 1000 ×; i) pore of glandular papilla, 600 ×; j) medial surface of body of tongue of 2-day guinea pig (general appearance), 100 ×; k) on dorsum of tongue of 3-day guinea pig, 150 ×; l) papillae on dorsum of tongue of 2-day guinea pig, 200 ×.

of postnatal development five or six taste pores which resemble pores on the papillae of the adult animal have appeared [1].

Fungiform papillae on the anterior free surface of the tongue of other animals born in a state of maturity (lambs, goats) have the same number of pores (over 20 in each papilla) at birth (Fig. 2d, h) as in the adult animal (Fig. 2a). However, these pores are not located on the raised portion as, in the guinea pig, but in the hollow (Fig. 2a, d, h, i), possibly on account of differences in their mode of feeding and processing of the food by these animals. The two other types of chemosensory papillae — foliate (guinea pig) and circumvallate (guinea pig, goat, lamb) do not differ significantly at birth from the papillae of the adult animal. Just as in the adult, they contain many open pores (Fig. 1d, e).

These findings are evidence that at birth the chemoreceptor apparatus of the tongue in animals born in a state of maturity is ready to perform its chemosensitive function, as is shown by the presence of the same number of open pores in all chemosensory papillae as in the adult animal.

The mechanoreceptor papillae of the tongue of animals born in a state of maturity are more completely formed at birth than in animals born immature [2] and in man [3]. For instance, the mechanoreceptor papillae of the tongue of the newborn of all species of animals studied have outgrowths (Fig. 1c, g, j, k, l; Fig. 2e, f, g) which project above the dorsal

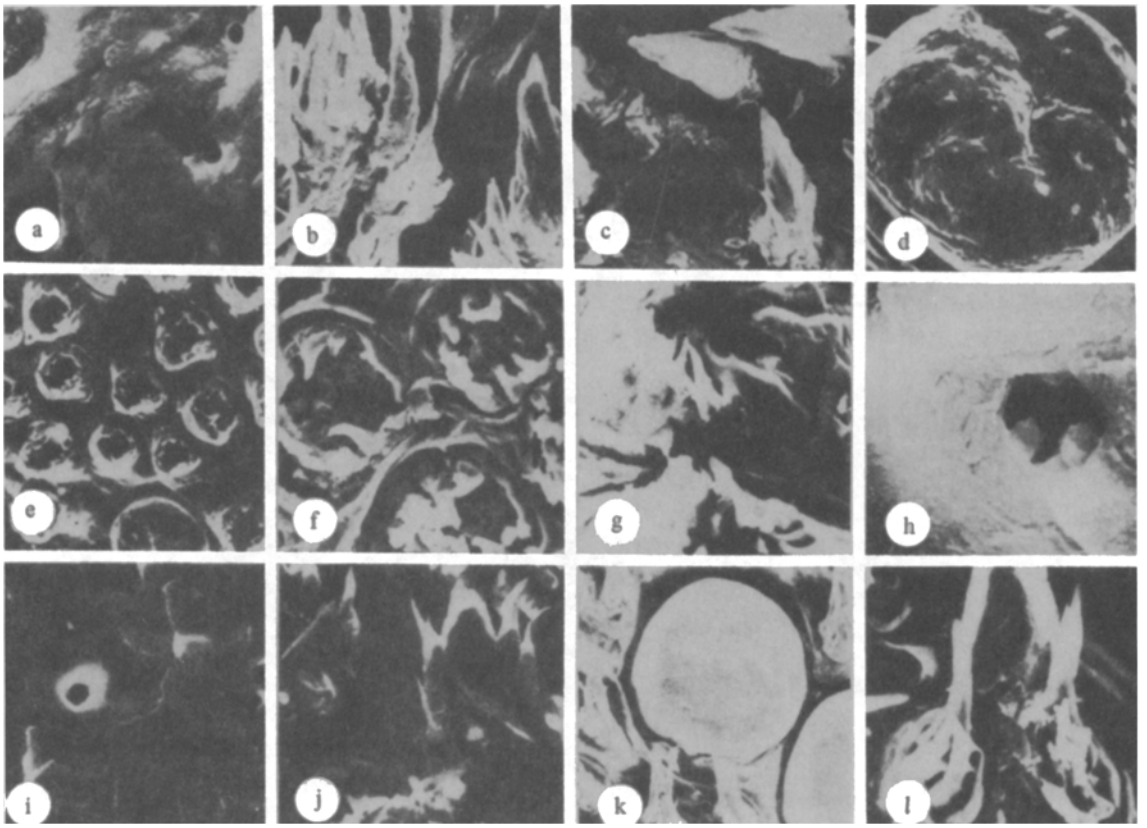

Fig. 2. Age changes in chemo- and mechanosensory papillae of lamb and goat tongue. a) Lateral fungiform papilla on body of tongue of an adult sheep, 750 ×; b) tactile papillae on medial part of tip of tongue of adult sheep, 300 ×; c) filiform papillae on lateral part of tongue of adult sheep, 100 ×; d) lateral fungiform papilla of body of tongue of newborn goat (pores indicated by arrows), 300 ×; e) fragment of medial part of tongue of newborn goat, 100 ×; f) tactile papillae on tip of tongue of newborn lamb, 300 ×; g) tactile papillae on body of tongue of newborn sheep, 300 ×; h) pore of fungiform papilla on medial part of root of tongue of newborn lamb, 1000 ×; i) pores of fungiform papilla on tip of tongue of 10-day goat, 3000 ×; j) tactile papillae on medial part of tip of tongue of 10-day goat, 300 ×; k) fungiform papilla on tip of tongue of 2-month lamb, 100 ×; l) tactile papillae in 2-month lamb, 500 ×.

surface of the tongue and which evidently can partly perform their function of determining the mechanical component of the food.

On the whole, however, the time course of formation of the tactile papillae of the tongue differs significantly in these different representatives of animals born in a state of maturity. For instance, the filiform papillae on the tip of the tongue of a 50-day guinea pig fetus have only one central process, whereas by the 3rd-4th day of postnatal development these papillae now also have lateral filiform processes (Fig. 1g), which are shorter at this time than in the adult animal. In sheep and goats this process of formation of tactile papillae of the tongue extends over a much longer period of time (Fig. 2f, g); even on the tenth day after birth (Fig. 2j) the filiform papillae on the anterior free surface of the tongue have not yet acquired their shape in the adult (Fig. 2b, c). It can be postulated that the formation of the tactile apparatus of the tongue in these animals is complete two months after birth.

The different times of formation of the tactile papillae of the tongue in different representatives of animals born in a state of maturity are evidently also linked with their manner of feeding. Young guinea pigs begin to display interest in the solid food characteristic of adult animals by the 3rd day of postnatal development. They grab solid food,

taste it, and eat a little of it, and this may be evidence that they need sensory analysis of the mechanical component of their food stimulus at this stage already. Lambs and goat kids begin to display interest in the solid food of adult animals much later, usually between the first and second months of life. It is by this time that their tactile papillae have acquired long processes and they can evidently perform their receptive function.

The tactile formations of the dorsal surface of the body and root of the tongue which participate in the formation of acts of sucking and swallowing are better developed at birth in all animals which are born in a state of maturity than the papillae on the anterior free surface of the tongue. The times of their formation are close to those observed in animals born immature.

A characteristic feature of the various species of animals born in a state of maturity is thus the earlier morphological and functional development of the chemosensory apparatus of the tongue than in animals born immature. The formation of fungiform papillae on the anterior free surface of the tongue evidently occurs near the time of the animal's birth. In this case it is impossible to speak of postnatal unsynchronized maturation of the chemosensory structures of the tongue, as has been demonstrated in animals born immature [2] and in man [3]. Antenatal unsynchronized development of taste papillae may perhaps exist, but further research is necessary to confirm or refute it. Proof that maturation of the chemosensory papillae of the anterior free surface of the tongue takes place actually during the antenatal period may be provided by electrical responses of the chorda tympani, recorded in fetuses and newborn lambs in response to adequate stimulation of the tongue, and also by experiments showing changes in the rate at which lamb fetuses swallow amniotic fluid when various substances are added to it [5].

The formation of the tactile apparatus of the tongue in animals born in a state of maturity is delayed relative to the chemosensory apparatus. This delay in development of mechanosensory papillae differs in different species of these animals: in young guinea pigs the tactile papillae are formed earlier than in kids and lambs, possibly due to the different times of gradual transition from the lactotrophic period to consumption of solid food, and the consequent necessity for sensory analysis of the mechanical component of the food.

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