Partial adaptation of taste

Carl Pfaffmann and J. B. Powers
BROWN UNIVERSITY

Abstract Electrophysiological recordings from the chorda tympani nerve of the rat were obtained during prolonged taste stimulation by sodium chloride (NaCl) solutions. The response consists of two phases: an initial transient response followed by a brief decline to a maintained steady state activity that shows little further decrement during 5 min. or longer of recording. The level of sustained discharge is determined by the concentration of the taste solution. This contrasts with complete adaptation observed in human psychophysical experiments, where all taste sensations disappear within a minute or less of steady application of a saline solution.

Electrophysiological activity in the chorda tympani nerve of one side of the rat's tongue was observed in the usual manner. A quantitative index of total nerve activity was obtained by means of a summator circuit and ink-writer recorder in which the deflection was proportional to the total magnitude of impulse discharge. The rat's tongue was enclosed in a flow chamber fitted with a rubber dam and system of tubes so that saliva was excluded and solutions could be flowed over the tongue for a controlled period of time. After rinsing the tongue with distilled water, various concentrations of sodium chloride were flowed over the tongue and left in contact for intervals as long as 5 min. In the first series of experiments, the taste solution was then rinsed off with distilled water and the decrement in response observed. In the second series of experiments, a test solution weaker than, equal to, or greater than the stimulating solution

was introduced into the tongue chamber and left in place for another 5 min.

Figure 1 shows a series of superimposed tracings of the summator records for a series of sodium chloride concentrations. The tongue was rinsed with water prior to each stimulation and allowed to rest for 5 min. This resulted in low level background activity. Test solution flowed during the first 15 sec. of the 5-min. period; thereafter, the solution remained in the flow chamber and on the tongue until the rinse water was applied at the end of the 5-min. period. It will be observed that upon flow of water there is a suppression of activity and then gradual return to baseline. Weak saline produced a slight transient followed by suppression and then somewhat higher than baseline level of activity. The stronger solutions produced a definite increment in response consisting of two phases: the initial transient and overshoot followed by a steady state level greater than baseline. The higher the concentration, the higher both the initial overshoot and the higher the final steady state level.

It is interesting to note that the decrement in discharge is the greatest for water but becomes systematically smaller with slight increases in saline concentration up to a value at which little change from resting level is observed. This might be considered to be a physiological taste neutral point, which in Fig. 1 is close to .003 M NaCl. The exact value of the neutral concentration depends upon a number of factors, including the prior history of stimulation and the interval between stimuli. Concentrations above this value elicit the usual increment in neural activity. The figure also shows that the decline to

Fig. 1. Superimposed tracings of summator records from rat chorda tympani (read from right to left). Time marker: 1-min. intervals. Upper signal marked S: time of stimulus flow. H₂O: application of water.

Fig. 2. Same as Fig. 1. S_1 : application of .1 M NaCl. S_2 : application of water or second NaCl stimulus. (Read from right to left.)

steady state activity is proportionately less for the .1 M NaCl solution than for the .03 M NaCl and weaker concentrations. A similar relation had been seen in earlier studies of single fiber frequency counts (Pffaffmann, 1941) and recently Halpern (1963) has described similar relations in summator recordings from the taste area of the solitary nucleus in the medulla. In Fig. 1 for example, the steady state to .1 M response after 5 min. has fallen to 64% of the initial transient response, whereas the steady state value for .03 M fell to 20% of the initial value.

There is the additional question of whether prior prolonged stimulation by salt solutions will affect the response to the same stimulus of different concentration when immediately placed on the tongue without prior distilled water rinse. In these experiments, the tongue was stimulated for 5 min. by .1 M NaCl and then followed immediately with the same or a different NaCl concentration. Figure 2 shows a composite tracing of summator responses. The prior stimulus elicits the usual transient and steady state level. Application of a more concentrated solution produces a transient increment in firing followed by a decline to a new steady state level higher than before. A less concentrated solution produces a transient decrement in response followed by a rise to a new steady state level, in this case lower than before. Water, of course, produces the largest decrement and undershoot and return to the prior base level of response.

The observation of a prolonged and maintained discharge to taste stimulation contrasts with the psychophysical observations by Krakauer and Dallenbach (1937), Bujas (1953), and others which show that the taste sensation to salty and other taste modalities adapts completely. Within 25 to 90 sec. there is a complete loss of taste sensation. Such effects have been confirmed in recent studies by McBurney and Pffaffmann (1963). Thus, there is the interesting question of whether the adaptation

reflected by the disappearance of taste sensation in man is due to a central process somewhere in the afferent input channel, as Beidler (1962) and Bujas (1953) have suggested, since the afferent input from the gustatory receptors appears to show only partial adaptation. We have recorded undiminished steady state responding in the chorda tympani nerve of the rat for as long as 20 min. after the onset of the stimulus. Recordings from the human chorda tympani nerve by Diamant et al., (1963) indicate similar response properties for the human chorda tympani response but their records have been carried out for only a few seconds. If further work shows that the response in the human chorda tympani is like that of the rat, it would appear that adaptation to gustatory stimuli is largely central rather than peripheral in locus.

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Note

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