

Effects of filter paper stimulus application on gustatory adaptation*

Herbert L. Meiselman and Cheryl Buffington

U.S. Army Natick Research and Development Command, Natick, MA 01760, USA

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Abstract. Eighteen subjects compared anterior dorsal flow with filter paper stimulation in producing gustatory adaptation over a three minute stimulation with either 0.1 or 0.36 M NaCl. Filter paper stimulation produced more adaptation, with the median judgement reaching zero for the 0.1 M NaCl. The percentage of subjects showing complete adaptation varied from 56% (0.1 M, filter) down to 5.5% (0.36 M, flow). Thus, filter paper application maximizes gustatory adaptation, but does not eliminate the phenomenon of substantial incomplete taste adaptations.

Introduction

A number of methodological variables have been shown to affect taste adaptation. The variable with probably the most consistent effect on the adaptation process is the concentration of the stimulus. Stronger stimuli take longer to adapt to and produce more instances of incomplete adaptation (Meiselman, 1972).

Meiselman (1968) showed that repeated sips of stimuli produced a lesser degree of adaptation than that produced by one sip held in the mouth for 5 minutes. This difference was attributed to the greater dilution of the stimulus when held in the mouth continuously, resulting in a greater adaptation for the weaker stimulus. Meiselman (1972) also compared the number of complete adaptations obtained with four different methods of stimulus presentation: sip, repeated sip, dorsal flow, and whole mouth flow. The anterior dorsal tongue flow method produced the greatest number of complete adaptations for all concentrations of salt stimuli, presumably due to the relatively stable stimulus and the effect of saliva dilution.

Although these methodological factors were shown to have significant effects in the observance of complete taste adaptation, a major conclusion from these and other studies is that a majority of subjects do not adapt completely, regardless of the testing methods employed. Consequently, in recent papers the attention has begun to shift from methodological factors, in attempts to produce more complete taste adaptations, to experiments which try to elucidate the factors which differentiate subjects who are taste adapters from those who are taste non-adapters. We have been able to determine that most subjects are consistent in their tendency to adapt completely within any one experiment (Meiselman & DuBose, 1976; DuBose, *et al*, 1977) and that most subjects are also consistent in their tendency to adapt completely after an interval of one year (DuBose and Meiselman, 1979). Differences in salivary sodium levels or in salt recognition thresholds do not appear to account for these individual differences in adaptation

(DuBose and Meiselman, 1979).

In addition to a shift in our research focus, we have also shifted our theoretical perspective. Taste adaptation is now seen within the context of gustatory stimulation under natural conditions of drinking. In such a model, sensory adaptation of taste is probably negligible (Halpern and Meiselman, 1980).

Recently Gent and McBurney (1978) have demonstrated that application of a taste stimulus on a small (13 mm in diameter) piece of filter paper yields greater adaptation than that reported in the experiments cited above by Meiselman and colleagues. Gent and McBurney found that the *median* magnitude estimate fell to zero (complete adaptation) for all but one strong stimulus. They attributed their different results to the stable stimulus presented with the filter paper method, and attribute others' reports of incomplete adaptation to the stimulus concentration changes which they feel have been unavoidably associated with previously used methods of stimulation. McBurney (1976) has argued that the taste system is extremely sensitive to slight changes in stimulus concentration. However, in their experiment 3 out of 12 subjects never showed complete adaptation to any stimulus, even with the filter paper technique, and there were other subjects who showed occasional absence of complete adaptation. Although filter paper application might stabilize the stimulus, the filter paper technique also presents an artificial condition in which the natural removal of stimulus material is blocked by the filter paper.

In view of our search for the critical variables controlling the completeness of taste adaptation, we decided to repeat the experiment with filter paper application and compare it to the traditional dorsal tongue flow method of stimulus presentation.

Method

Subjects

Eighteen subjects, 12 male and 6 female, aged 16 to 41 participated in this study. All were laboratory personnel, who had previously taken part in other research projects, but were naive as to the purpose of the present study.

Stimuli

The stimuli were two solutions of reagent grade sodium chloride and distilled water. Molar solutions of .1 and .36 were chosen for this study as a continuation of previous research concerning adaptation. The stimuli were kept in a water bath at 36°C.

Procedure

Method 1. A continuous flow procedure described by DuBose *et al.*, 1977 was used to present the two salt solutions to the tongue through Tygon Tubing. The subject's tongue was extended into a tongue fixation apparatus similar to the one described by Meiselman and Halpern (1973).

Subjects were required to rinse with distilled water prior to the onset of the 3

minute trial. The initial contact of the stimulus to the tongue was assigned a modulus of 10, and every 15 seconds subjects recorded their judgment of the solution's intensity in proportion to the standard. A 1 minute rest interval between the two stimulus presentations was used.

The solutions for both Method 1 and Method 2 were mixed and drawn from the same container. Each subject completed all four trials in the same session. Presentation orders were randomized with the restriction that both stimuli be presented with one method before beginning the other.

Method 2. Circular pieces of Whatman grade # 1 chromatography paper, 12mm in diameter, were saturated with the same solutions used in Method 1. Subjects extended their tongue for approximately 15 seconds. The stimulus was then placed on the tongue with forceps as described by Gent and McBurney (1978). Subjects were required to give magnitude estimations of the solution's intensity beginning with the modulus of 10 and to respond at 15 second intervals at the experimenter's signal. As in Method 1, a rest period of 1 minute and a distilled water rinse were used.

For individual subjects, the location of the saturated paper was the same for both stimulus trials. However, the placement of the stimuli varied among subjects; for half of the subjects the stimuli were placed on the right portion of the anterior dorsal surface of the tongue, and for the other half the stimuli were placed on the left portion.

Results and Discussion

Figures 1 and 2 illustrate the taste intensity functions for the two methods of stimulus presentation over the 3 minute test period. The curves for the filter paper technique lie below those for the flow technique after about 1 minute of stimulation for both NaCl concentrations, indicating more adaptation. In the case of .1M NaCl, the median magnitude estimate of intensity using the filter paper fell to zero within 180 seconds. The median magnitude estimate of .36M NaCl intensity decreased to half of its original value within 105 seconds.

Examining the individual subjects, a comparison of the two methods of presentation is shown in Table 1. More than 60% of the subjects reported adaptation reached in a shorter duration or adaptation to a lower perceived intensity with the filter paper technique than with the traditional flow presentation.

The numbers of complete adaptation, defined as two consecutive reported zeros, is shown in Table II. Use of filter paper and 0.1 M NaCl resulted in the largest number of complete adaptations (10/18 or 56%) yielding a median judgment of zero at the end of 3 minutes. The other conditions with 0.36 M NaCl or flow produced 33% (6/18) complete adaptation or less. Both filter paper conditions produced a greater number of complete adaptations than both flow conditions, and both low concentrations produced a greater number of complete adaptations than both high concentrations.

Thus, these data support the finding of Gent and McBurney (1978) that filter paper stimulation can produce complete adaptation when defined as the median judgment of a group. The question remains, we believe, as to why such a relatively large number of subjects fail to demonstrate complete adaptation. Both

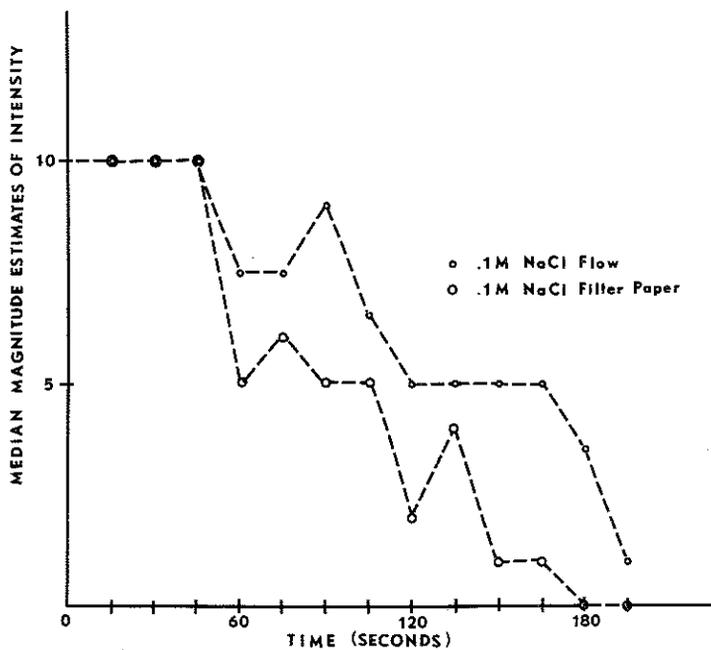


Fig. 1. Median magnitude estimates of intensity for 0.1 M NaCl presented with either the anterior dorsal tongue flow or with the 12 mm circles of filter paper on the anterior dorsal tongue.

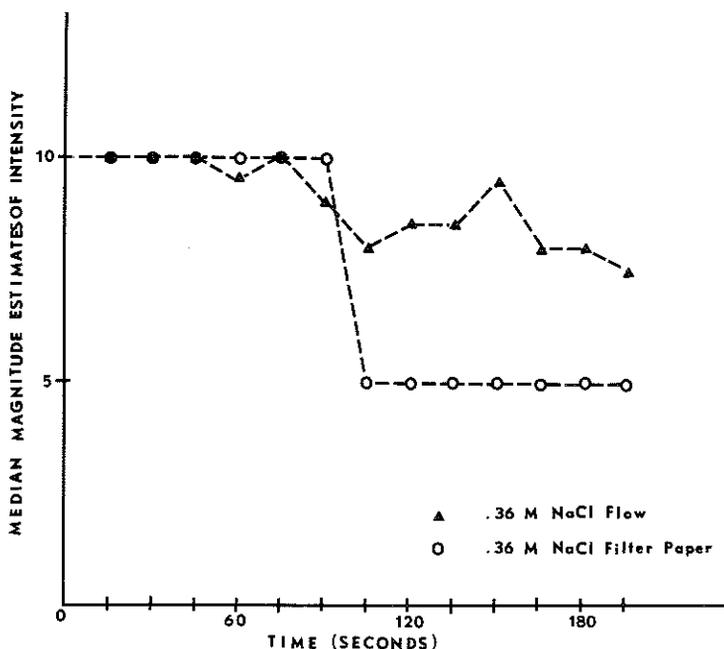


Fig. 2. Median magnitude estimates of intensity for 0.36 M NaCl presented with either the anterior dorsal tongue flow or with the 12 mm circles of filter paper on the anterior dorsal tongue.

Filter paper stimulation and gustatory adaptation

Table I. Effect of filter paper presentation on adaptation, compared with flow method.

Stimulus	Subjects reporting Faster * or more complete ** adaptation	Subjects reporting (approximately) same degree of adaptation	Subjects reporting slower * or less complete ** adaptation
.1 M NaCl	11/18	4/18	3/18
.36 M NaCl	11/18	3/18	4/18

* Duration to reach lowest reported perceived intensity.

** Magnitude estimation of lowest reported perceived intensity.

Table II. Number of complete adaptations (two consecutive zeros).

	Flow	Filter
.1 M NaCl	6/18	10/18
.36 M NaCl	1/18	6/18

studies demonstrate that some subjects fail to completely adapt even under limiting, artificial conditions involving mechanical blocking of natural stimulus movement by filter paper. Complete taste adaptation to the point of no reported sensation is possibly more a laboratory artifact than a useful construct of taste in the real world.

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