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Further Studies on the Influence of Verbal Suggestion on the Parotid Gland Response to Gustatory Stimuli.* (30081)

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Lashley(5) and Winsor(8,9,10,11) have shown that the parotid gland reflexes are excited by mechanical, chemical, and protopathic stimuli of the oral mucosa. Jenness and Hackman(4) reported a reduction in the parotid secretory rate while the subjects were in "hypnosis." Bowles and Pronko(2) and Pronko and Hill(6) used suggestions given under "hypnosis" to influence salivary gland response in humans.

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In our first investigation(3) parotid gland secretory response to gustatory stimuli could be altered by direct verbal suggestions in subjects who had previously obtained low scores on a standardized suggestibility scale(1). The present study was designed to confirm these previous findings and, in addition, to ascertain whether a greater degree of alteration in parotid secretory response could be produced by suggestions in "highly suggestible" as opposed to relatively "non-suggestible" subjects.

Materials and methods. Eighty 2nd-year dental student volunteers were assessed on their response to the Barber Suggestibility Scale(1) (*e.g.*, arm levitation, inability to

unclasp hands, etc.), administered while awake. Sixteen subjects, 8 who scored in the top quartile (highly amenable to suggestion) and 8 who scored in the lowest quartile (relatively non-amenable to suggestion) were used in the experiment.

Gustatory stimulation and saliva collection. At each testing period the subjects were randomly paired and the gustatory stimulus applied by having the partner swab the other's tongue. Using a wetted cotton tipped application stick, a constant application rate of 4 swabs per minute was maintained throughout the test period. During each application, the swab was passed along the lateral edges of the tongue and over the entire dorsal surface.

Parotid saliva was collected unilaterally using the vacuum cup(7). The subjects were tested early in the morning and had been instructed to refrain from eating, smoking, or brushing their teeth prior to the test period. Salivary secretions were collected in centrifuge tubes graduated to 0.1 ml. Flow rate was determined by measuring the volume of saliva secreted during a 10-minute interval.

A standard collection procedure was used throughout the experiment. Initially a 5-minute "clearance" sample of saliva was collected and discarded. This allowed the gland sufficient time to adjust to the stimulus. Immediately afterward a 10-minute "experimental" sample was collected. The subjects were then given a drink of water and "rested" for 5 minutes. This sequence was repeated with the next stimulus.

Prior to the series of test conditions the subjects were familiarized with the placement of the vacuum cup, method of applying the stimuli, type of stimuli, and collection sequence. This introductory period allayed any apprehension which might affect the normal secretory response.

Two series of experiments were then carried out using, as the gustatory stimuli, citric acid solution (2%) and distilled water. Using a single stimulus the parotid gland secretion response was determined without and with direct verbal suggestion. When specific verbal suggestion was used it was given prior to the "clearance" sample, and repeated once before and once during the collection of the "experimental" saliva sample. The suggestion given when water was suggested to be citric acid was as follows:

You all remember previously tasting the sour solution. Disregard the actual taste of the solution we are using today, and vividly imagine that it is the same sour solution you tasted previously. Continue to imagine vividly, trying as best as you can all during the collection interval, that the solution is the same sour, acid solution you tasted previously.

The suggestion given when citric acid solution was suggested to be tasteless was as follows:

You are to disregard the actual taste of the solution and vividly imagine, to the best of your ability, that the solution being swabbed on your tongue is a tasteless solution of water.

The sequence of testing for the first experimental session was: water without suggestion; water suggested to be a strong, sour solution; water without suggestion; and water suggested to be a strong, sour solution.

The sequence of testing for the second experimental session was: 2% citric acid solution without suggestion; citric acid suggested to be tasteless; citric acid solution without suggestion; citric acid suggested to be tasteless; and citric acid without suggestion.

On both days the series of tests were conducted immediately one after the other in accordance with the "clearance," "experimental," and "rest" sequences as stated previously.

Results and discussion. Variability of response in a single experimental session. The mean secretion rates for the first experimental session are presented in Table I. Two-tailed t tests were used to determine whether there was any significant variation in secretory response when a stimulus was given twice during a single experimental session. When stimulated by water alone twice during the same session the mean secretory responses (0.575 and 0.570) did not differ significantly ($p>0.8$). Similarly, there was no significant difference between the mean secretion rates obtained during the first experimental ses-

TABLE I. Mean Secretion Rates During Session 1 with Water as Water and Water Suggested To Be Citric Acid (Sour).

Stimulus	Mean secretion rate (ml/10 min)	Standard error of mean
1. Water as water	.575	± .09
2. " as citric	.695	± .11
3. " as water	.570	± .097
4. " as citric	.778	± .12

sion (0.695 and 0.778) when water was suggested to be a strong, sour solution ($p>0.7$).

The mean secretion rates for the second experimental session are presented in Table II. Analysis of variance was used to determine if the secretion rate response to citric acid solution without suggestion was consistent during this session. The analysis indicated that the difference in secretory rate in response to stimuli 1, 3, and 5 was not significantly different ($F>1.0$). A two-tailed t test was used to evaluate the difference between the rates obtained when citric acid was suggested to be tasteless. This analysis indicated that the difference in secretory rates between stimuli 2 and 4 were non-significant ($p>0.9$).

In summary, these data indicate that the response to any given stimulus is quite consistent in a single experimental session.

Response to water suggested to be sour. If the suggestions were effective, salivary secretion rate should be higher when water was suggested to be sour than when water was given without suggestions (Table I). To test this prediction, a one-tailed t test was performed between (a) subjects' average secretory response to water given as water (average of stimuli 1 and 3 in the first experimental session) and (b) subjects' average secretory response to water suggested to be sour (average of stimuli 2 and 4). This analysis showed that salivary secretory response to water suggested to be sour was significantly higher than response to water given without suggestions ($t = 3.28$; $p<.001$).

TABLE II. Mean Secretion Rates During Session 2 with Citric Acid as Citric Acid and Citric Acid Suggested To Be Tasteless (Water).

Stimulus	Mean secretion rate (ml/10 min)	Standard error of mean
1. Citric acid	4.034	± .98
2. " " suggested to be tasteless	3.047	± .50
3. Citric acid	3.669	± .35
4. " " suggested to be tasteless	3.050	± .58
5. Citric acid	3.643	± .90

Based on the hypothesis that the secretory rate would be greater when water was suggested to be sour than when water was given without suggestion, an up-down-up secretory pattern was expected for the second, third, and fourth successive stimulations, respectively, in the first experimental session (Table I). If the change in rate was due to chance, this predicted pattern would occur only twice among the 16 subjects. Eight of the 16 subjects showed the predicted up-down-up secretory pattern during the second, third, and fourth stimulations. This observed frequency was significantly different from the chance frequency by chi-square test beyond the 0.001 level of probability.

Response to citric acid suggested to be tasteless. If the suggestions were effective, salivary secretion rate should be lower when citric acid was suggested to be tasteless than when citric acid was given without suggestions. To test this prediction, a one-tailed t test was performed between (a) subjects' average secretory response to citric acid given without suggestions (average of stimuli 1, 3, and 5 in the second experimental session) and (b) subjects' average secretory response to citric acid suggested to be tasteless (average of stimuli 2 and 4). This analysis showed that salivary secretory response to citric acid suggested to be tasteless was significantly lower than response to citric acid alone at better than the 10% level of confidence ($t = 1.56$).

Based on the hypothesis that the secretory rate would be lower when citric acid was suggested to be tasteless than when citric acid was given without suggestion, a down-up-down-up secretory pattern was expected for the second, third, fourth, and fifth stimulations, respectively, in the second experimental session (Table II). This pattern should occur about once (0.93) by chance

for the 15 subjects.† Five subjects showed the predicted pattern. This observed frequency was significantly different from the chance frequency beyond the 0.001 level of probability by chi-square test.

The above data indicate that: (1) parotid secretory rate tends to increase when water is suggested to be sour, then tends to decrease when water is given as water, and then tends to increase again when water is suggested to be sour; and (2) parotid secretory rate tends to decrease when citric acid is suggested to be tasteless.

By assessing response to water with and without suggestions in a single session, by assessing response to citric acid with and without suggestion in a single session, and by using a person other than the subject to apply the stimulus, the altered secretory response was shown not to be due to diurnal or day to day variation and not be due to subject's manipulation of the stimulus but to be due to the verbal suggestions. These findings confirm the results obtained previously(3).

Response of "highly suggestible" and "non-suggestible" subjects. A series of statistical analyses was performed to ascertain whether subjects previously rated as highly responsive and as non-responsive to the Barber Suggestibility Scale differed in salivary responses to the specific suggestions used in this experiment. These analyses showed that the 8 subjects who had been previously rated as highly responsive and the 8 who had been rated as relatively unresponsive to suggestions of arm heaviness, inability to unclasp hands, selective amnesia and the other suggestions included in the Barber Suggestibility Scale did not differ significantly in salivary response to suggestions that water was sour or that citric acid solution was tasteless. This outcome appears to indicate that a subject's physiological response to suggestions to imagine a taste stimulus cannot be easily predicted from the subject's previous overt behavioral responses to other types of suggestions, such as suggestions that an arm is becoming heavy or suggestions that the subject cannot take his clasped hands apart.

Summary. Two gustatory stimuli, water and citric acid, were presented sequentially to 16 subjects with and without direct verbal suggestions that water was sour and that citric acid was tasteless. Half of the subjects had been previously rated as "highly suggestible" and half as relatively "non-suggestible" according to a standardized suggestibility scale. The results showed that: (1) there was no significant variation in parotid secretion rates when the same stimulus was repeated during a single experimental session; (2) direct verbal suggestion significantly altered parotid gland secretion rates in both the "highly suggestible" and the relatively "non-suggestible" subjects.

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† A centrifuge tube containing a salivary sample from one subject was inadvertently dropped on the floor and could not be used. The analysis in this case is therefore based on the remaining 15 subjects.

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