Empirical Research Paper, APA Style (Psychology)

The header consists of a shortened title (no more than 50 characters) in all capital letters at the left margin and the page number at the right margin; on the title page only, the shortened title is preceded by the words "Running head" and a colon.

The Influence of Sex and Learning on Taste Sensitivity

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Full title, writer's name, and school halfway down the page.

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An author's note (optional) gives the writer's affiliation and specific information about the course. It can also provide acknowledgments and contact information.

Marginal annotations indicate APA-style formatting and effective writing.

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This paper follows the style guidelines in the *Publication Manual of the American Psychological Association,* 6th ed. (2010).

Abstract, a 100-to-150-word overview of the paper, appears on a separate page. The heading is centered and not boldface.

Numerals are used for all numbers in the abstract, even numbers under 10. (See p. 7 for numbers in the body of the paper.)

Keywords (optional) help readers search for a paper online or in a database.

Abstract

Perceptual learning enhances a person's ability to detect specific stimuli after the person experiences exposure to the stimuli. Perceptual learning has been observed in taste aversion, but it has not been extensively investigated in taste sensitivity. The current study examined the effect of perceptual learning in taste thresholds of females and males. I studied taste sensitivity longitudinally, testing every other day for 1 month, in 6 young adults (3 males, 3 females) between 19 and 21 years of age. Taste thresholds were determined using an electrogustometer at 4 tongue locations (front-left, front-right, back-left, back-right) corresponding to the chorda tympani and glossopharyngeal nerves. Results indicate that males and females demonstrated a perceptual learning effect—thresholds decreased with practice—and were consistent with previous research that females' thresholds were lower than males' for all tongue locations. In contrast to previous research in olfaction (Dalton, Doolittle, & Breslin, 2002), both males and females "learned." However, females overall performed better in the task, which is consistent with the previous literature on the chemical senses.

Keywords: perceptual learning, taste aversion, taste sensitivity, sex differences

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The Influence of Sex and Learning on Taste Sensitivity

Full title, repeated and centered, not boldface.

The development of taste involves changes in taste preferences and aversions that are influenced by personal experiences. These can vary among cultures, age groups, and sexes (Nakazato, Endo, Yoshimura, & Tomita, 2002; Tomita & Ikeda, 2002). Through various experiences with different taste stimuli, people develop taste acuity (Scahill & Mackintosh, 2004). Taste acuity allows people to distinguish between different flavors and determine their taste preferences and aversions (Tomita & Ikeda, 2002). Taste sensitivity allows people to detect the differences between various stimuli, such as electric or hot and cold, through the nerves in the tongue (Nakazato et al., 2002). The detection and differentiation of taste stimuli determine how people perceive food and develop dietary habits.

First part of the introduction briefly describes previous research on the topic and provides background about the writer's experiment.

The main purpose of this study was to determine if perceptual learning occurs in taste sensitivity by measuring taste thresholds in the tongue. An electrogustometer delivered electric stimuli to participants' tongues. (The threshold is the minimum amount of current required to discriminate between two short pulses of current.) Perceptual learning has been found in taste aversion research but, to my knowledge, has not been examined directly in taste sensitivity measured through electrogustometry. But Lobb, Elliffe, and Stillman (2000) did suspect learning when taste thresholds continued to decrease as testing progressed after the initial 10 sessions were omitted. Taste aversion studies have shown that participants demonstrated a learning effect as they gained exposure to electric stimuli (Bennett & Mackintosh, 1999; Blair & Hall, 2003; Dwyer, Hodder, & Honey, 2004).

Conderman establishes the importance of her research in the context of previous research on the topic.

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A second purpose of this study was to determine whether sex differences play any part in taste sensitivity. Dalton et al. (2002) demonstrated that females experienced learning, while males did not. Yet Cain (1982) found that females outperformed males but that males could reach the performance level of females if they received more exposure to the stimuli. My hypothesis was that female participants would show lower taste thresholds, indicating higher taste sensitivity, than males. In addition, given more experience, males would have similar taste thresholds to females and thus would also demonstrate learning. I also anticipated that the right locations of both males' and females' tongues would have lower taste thresholds than the left tongue locations, as suggested by Nakazato et al. (2002).

After stating the main purpose and secondary purpose of her research, Conderman presents her hypothesis.

The Learning Effect

Headings organize the introduction into sections that briefly review the literature about various aspects of the topic.

Perceptual learning develops through exposure to specific stimuli; exposure promotes an increase in discrimination and a decrease in generalization between different stimulations (Bennett & Mackintosh, 1999). When the stimuli share at least one attribute, they are slightly difficult to differentiate. The level of difficulty can be adjusted by increasing or decreasing the presence of the common attribute. Scahill and Mackintosh (2004) found that the difference in difficulty level of previously exposed stimuli had no effect on perceptual learning. Rats previously exposed to easy differential taste tasks demonstrated enhanced discrimination on more difficult tasks and vice versa. When the rats had previous experience with the stimuli, they displayed higher levels of discrimination than subjects with no prior exposure (Scahill & Mackintosh, 2004).

Source: Hacker Handbooks (Boston: Bedford/St. Martin's, 2013).

The ability to discriminate is also affected by the type of exposure used when introducing the stimuli. Two commonly studied types of stimulus exposure are intermixed and blocked. In intermixed exposure, the presentation of differing stimuli is alternated (Stimulus 1, Stimulus 2, Stimulus 2, Stimulus 1); in blocked exposure, the stimuli presentations are separated (Stimulus 1, Stimulus 1, Stimulus 2, Stimulus 2). Intermixed exposure has repeatedly been shown to lead to higher discrimination abilities than blocked exposure (Bennett & Mackintosh, 1999; Blair & Hall, 2003).

Similar findings have been discovered in humans. Dwyer et al. (2004) introduced stimuli to participants through either intermixed or blocked exposure. Participants were presented with two stimuli and were asked to report whether the flavor stimulus being received was the same as or different from the previous stimulus. Overall, tasks performed after intermixed exposure showed higher discrimination and lower generalization between stimuli. Participants' reports during same/different tasks were more accurate when provided with intermixed exposure prior to testing. However, this occurred only with participants who received feedback after their responses. Participants who did not receive feedback placed negative attributes toward one of the intermixed stimuli but did not have higher accuracy (Dwyer et al., 2004).

Source is mentioned earlier in the paper. In subsequent citations for a source with three to five authors, "et al." is used after the first author's name in the text and in parentheses.

Sex Differences

One factor that has not been extensively studied in perceptual learning is sex differences. Dalton et al. (2002), however, did notice sex differences: Females' olfactory thresholds continually decreased while males displayed no significant change. Cain (1982)

Source: Hacker Handbooks (Boston: Bedford/St. Martin's, 2013).

reported that females were able to identify more odors correctly than males. One explanation for the difference in performance was the sex difference suspected in cognitive functioning (Cain, 1982). Several studies have reported that females and males differ in spatial and verbal tasks, but the findings are controversial because several studies have used different assessment tools and have used generalities among the data when forming conclusions (Cain, 1982; Lohman & Lakin, 2009). Yet cognitive differences between the sexes remain a possible explanation.

Two or more sources in one parenthetical citation are given alphabetically, as they appear in the reference list. The sources are separated with semicolons.

Sex differences have been thoroughly studied in taste through the use of aqueous solutions. Frye and Demolar (1994) found a significant sex difference in salt preference using various salt dilutions applied to popcorn. Females demonstrated a lower salt preference than males, but no sex difference was found in the participants' taste acuity (Frye & Demolar, 1994). Curtis and Contreras (2006) confirmed that female rats preferred lower concentrations of salt than males and had a higher sensitivity to salt solutions. Females were also found to have lower taste thresholds than males (Curtis & Contreras, 2006).

For a source with two to five authors, "and" is used before the last author's name when the source is cited in the text; an ampersand is used in parentheses.

Taste Methodology

Electrogustometry is a portable and efficient testing mechanism that is used both clinically and in scientific research to determine taste thresholds (Murphy, Quiñonez, & Nordin, 1995; Stillman, Morton, & Goldsmith, 2000; Stillman, Morton, Hay, Ahmad, & Goldsmith, 2003). The electrogustometer delivers a small electric current that causes the saliva coating the tongue to become acidic, producing a sour taste (Lobb et al., 2000; Stillman

Source: Hacker Handbooks (Boston: Bedford/St. Martin's, 2013).

2000; Stillman et al., 2000). The tool is used to evaluate taste disorder classification, lesion identification in facial paralysis, nerve disease diagnoses, and diabetic taste disturbances (Tomita & Ikeda, 2002). Since its release in the 1950s, the electrogustometer has repeatedly been tested for its limitations, reliability, and validity (Lobb et al., 2000; Murphy et al., 1995; Stillman et al., 2000; Stillman et al., 2003; Tomita & Ikeda, 2002). Tomita and Ikeda (2002) stated that the TR-06 model has enhanced improvements that decrease limitations and increase reliability and validity. Murphy et al. (1995) used the TR-06 model and determined that the electrogustometer had high test-retest reliability, but Lobb et al. (2000) found that electrogustometry test-retest reliability was questionable.

Method

Method section begins with a main heading, boldface and centered. Subsections are indicated by second-level headings, flush left and boldface.

Participants

Participants were recruited through the college resident assistant program. Each participant provided written consent prior to testing. Taste sensitivity was studied in six young adults (three males, three females), ranging from 19 to 21 years of age, for one month with no more than one day separating sessions. There were a total of 15 testing sessions per participant. All participants were screened prior to testing and reported being nonsmokers with no current medication intake.

In the body of paper, all numbers under 10, including numbers of participants, are spelled out. (See p. 2 for numbers in the abstract.)

Materials

The Rion TR-06 electrogustometer with a 5-mm diameter stainless steel anode administered an electric stimulus directly to the tongue. The levels of electric current are listed in Table 1.

Source: Hacker Handbooks (Boston: Bedford/St. Martin’s, 2013).

Conderman uses a table to present data about the device she used for the experiment. A short table appears immediately following its mention in the text.

Table 1

Electrogustometry Currents for Testing Taste Sensitivity

dB	−6	−4	−2	0	2	4	6	8	10	12	14	16	18	20	22	24	26
μA	4	5	6.4	8	10	13	16	20	25	32	44	50	64	80	100	136	170

Note. The electrogustometry currents are shown in dB on the dial of the Rion TR-06 electrogustometer. The corresponding μA levels are as given in Kuga, Ikeda, Suzuki, & Takeuchi (2002).

Procedure

Numbers denoting approximate increments of time are spelled out (*at least one hour*).

Participants were instructed not to eat or drink anything besides water at least one hour prior to testing. During each trial, two low-level electric pulses were presented in quick succession to the same location on the tongue. One stimulus was a standard stimulus that remained constant at 4 μA, a very low current. The other stimulus was a test stimulus, which varied in intensity. All testing began with pulses at 4 μA and 13 μA. Participants responded by reporting which of the stimuli seemed stronger, generally through finger taps. Participants' tongues were tested on the four locations corresponding to the chorda tympani and glossopharyngeal nerves (front-left, front-right, back-left, back-right). Tongue locations were tested in the same sequence for every session, starting at the back-left and ending at the front-right. Stimulus duration was set at 0.5 s (Lobb et al., 2000). Sessions were held at approximately the same time of day for each participant throughout the study.

Numbers denoting specific increments are expressed in numerals (*0.5 s*).

After participants reported five consecutive correct responses (identifying which stimulus seemed stronger), a "reversal" occurred—the test stimulus became higher or lower than the

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previous test stimulus. For all reversals after the first, the strength of the test stimulus increased after one inaccurate response and decreased after two accurate responses (Frank, Hettinger, Barry, Gent, & Doty, 2003; Miller, Mirza, & Doty, 2002). Electric stimulation continued until seven reversals occurred per location (Miller et al., 2002).

Statistical Analysis

Taste thresholds were calculated for each participant using the geometric mean of the last four reversals in each session (Ajdukovic, 1991). Two analyses of variance (ANOVA) for repeated measures were used. The first 2 × 2 × 15 design was used to determine the effect and interactions of tongue location (back-front), sex (male-female), and number of sessions. The second 2 × 2 × 15 design was used to determine the effect and interaction of tongue location (back left-right), sex, and number of sessions.

Conderman uses familiar terminology in the field and standard notation to describe the experiment design.

Results

The taste thresholds across trials for males and females in the back and front tongue locations are shown in Figure 1. Across sessions, taste thresholds (that is, the minimum current required to determine the difference between two pulses) decreased for males and females in the back tongue locations. A repeated-measures ANOVA revealed a main effect of session, $F(1, 14) = 4.603$, $p = 0.000$, and location, $F(1, 1) = 22.843$, $p = 0.009$. There was also an interaction between session and location, $F(1, 14) = 2.750$, $p = 0.004$. A second repeated-measures ANOVA used to analyze the back left and right taste thresholds reported no main

Conderman uses the Results section to discuss the numerical data from her experiment. She presents the data graphically in two figures.

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Conderman uses a line graph, with conventional notation, to display data from her experiment.

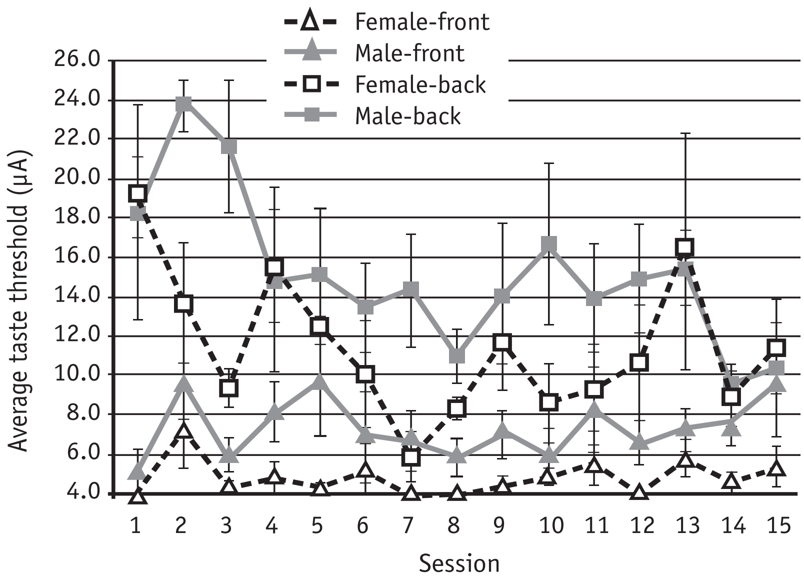

Figure 1. Perceptual learning in taste sensitivity in males and females, for front and back tongue locations. Error bars represent standard errors.

effect of session, *F*(1, 14) = 4.605, *p* = 0.535, or location, *F*(1, 1) = 0.135. Participants showed no significant learning in the back left and right tongue locations across sessions.

Females' taste thresholds were initially lower than males, but as sessions progressed, male and female thresholds became similar. Male-female differences were not found in session or location, as revealed in both repeated-measures ANOVA. However, differences in male and female taste thresholds were detected in the four locations. Figure 2 illustrates differences between male and female average taste thresholds in all tongue locations. In all locations, females had lower taste thresholds.

Source: Hacker Handbooks (Boston: Bedford/St. Martin's, 2013).

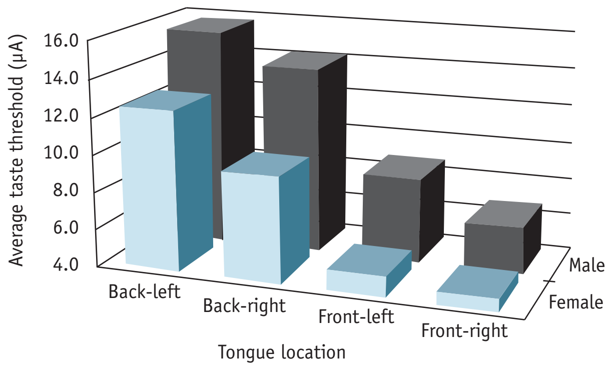

Figure 2. Average taste thresholds for the four tongue locations in males and females.

Figure number and caption are placed below the figure.

Discussion

Results supported the existence of perceptual learning in taste sensitivity, unlike odor perception (Dalton et al., 2002). All participants' taste thresholds decreased as sessions progressed—that is, their ability to detect differences between two stimuli increased. This finding supports previous research, which stated that participants who receive more exposure to a stimulus will have a greater ability to distinguish between different stimuli (Scahill & Mackintosh, 2004). Initially, females' thresholds were lower than males', but in the last three sessions, male and female thresholds became similar. This indicates that with increased exposure, males were able to experience levels of taste sensitivity similar to those of females.

In the Discussion section, Conderman interprets the results of her experiment in the context of previous research.

Participants received intermixed exposure to the same range of stimuli throughout the study. This procedure has been shown to increase discrimination and perceptual learning (Bennett & Mackintosh, 1999; Blair & Hall, 2003). Unlike previous experiments,

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more than three stimuli were used throughout the study, but all stimuli were compared to the same single stimulus, 4 μA. According to Blair and Hall (2003), this should have increased the participants' ability to distinguish between the stimuli.

No significant sex difference was determined, but small differences were found between male and female thresholds across sessions and in all four tongue locations. Overall, females had lower taste thresholds, supporting previous chemical senses research that has reported higher performance in females (Cain, 1982; Dalton et al., 2002). Cain (1982) proposed that cognitive abilities were a possible cause of the sex differences. With electrogustometry, however, participants did not have to be outwardly verbal or perform spatial tasks (Lohman & Lakin, 2009). Cognitive abilities are not believed to play a factor in this study in regard to sex differences.

As for tongue location, lower thresholds were exhibited on the right side of the tongue than on the left, as found by Lobb et al. (2000) and Nakazato et al. (2002). The difference between tongue locations has been thought to be due to taste bud density. The distribution of taste buds across the tongue has been found to vary in number and also to be discontinuous among the different regions (Miller & Bartoshuk, 1991). Miller et al. (2002) examined taste bud density in four front tongue locations and found that the number of taste buds was relevant to taste sensitivity. Locations with higher taste bud density had higher taste sensitivity (Miller et al., 2002). The effect of taste bud density needs to be studied further.

Conderman points to an area for further research.

Source: Hacker Handbooks (Boston: Bedford/St. Martin's, 2013).

It is common in electrogustometry research for only a limited number of participants to be used (Loucks & Doty, 2004; Miller et al., 2002). For example, Lobb et al. (2000) used two participants for three months to determine changes in taste threshold over time. While the number of participants was low, the researchers collected a large number of data points. In the present study, six participants were used with a total of 90 data points collected, which can be considered a reliable number of data points in the investigation of the learning effect.

Conderman explains why her data are valid statistically.

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List of references begins on a new page. The first line of each entry is at the left margin; subsequent lines indent ½". Double-spacing is used throughout.

List is alphabetized by authors' last names. All authors' names are inverted; an ampersand separates the last two authors.

A work with up to seven authors lists all authors' names. A work with more than seven authors lists the first six followed by three ellipsis dots and the last author's name.

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