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Analysis of the Impact of Age and Gender for the Differential Threshold Level and Discrimination Power on Gustation Modality

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ABSTRACT

Discrimination power of consumer, which is known as the differential threshold level is an important dimension in product development and marketing activities of the sector of food science. This study examined the effect of demographic factors; age and gender for differential threshold level on two gustation modalities, salt and sugar. Study was conducted according to the ISO5495:2005(E) pared comparison for standard salt and sugar samples respect to three reference samples using 180 selected respondents. Each respondent were gone through 15 comparison for each tastant, besides responds were collected through a questionnaire and analyzed by SPSS 22.0 statistical software under the significance level of 0.05. Results showed; differential threshold level has no linear correlation (P>0.050) with age and gender for both gustations, but younger ages and female gender shows higher discrimination ability than older ages and gender male. Discrimination between salt concentrations was easier than on behalf of sugar taste for both genders, but females showed a higher discrimination power than males.

Keywords: *Age, Differential threshold level, Discrimination Power, Gender, Gustation*

1. INTRODUCTION

Human sensory system is remarkably sensitive towards stimuli as it can detect small concentrations of molecular compounds and even differentiate or discriminate between molecular variations and concentration variations of the same compound. This process is involved by the sensory threshold levels, where differential threshold level is effect upon the discrimination power of the respondent. The noticeable difference in the amount of the stimuli which detect at least half time is known as the Just Noticeable Difference or JND [1]. According to some studies, this limen is known as least perceptible difference or differential threshold level [2].

The ratio of the JND/reference considered constant as it's a fixed proportion. As described by Ernst Heinrich Werber (1975-1978);

$$K = \frac{d(I)}{I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where K is a constant (Werber constant), and original intensity of the particular stimulation, the addition required for the change to be perceived from the JND are denoted respectively by; I and $d(I)$. Since JND is not an exact quantity of stimuli as it's a statistical value, JND even can vary from trial to trial for a same individual. Therefore it's generally reported as the difference in which a person notices 50% of trials.

Differential threshold level or JND is linked with psychophysics in the sector of experimental psychology; this can vary with many factors. Except to the psychological factors, physiological, socio economic and demographic factors can affect differential threshold level [3]. Further magnitude of the stimuli and even on the sensory modality, differential threshold/JND canvary with.

Sensory declining with the age is a generic process. Age and gender are the most vital factorsof demographic settings which effect for the sensation and thresholds [4]. Hence this study reviews the

impact of age and gender for the differential threshold level on two taste modalities; salty and sweet.

2. METHODOLOGY

2.1 Selection of respondents for the study

Initially, 190 persons in three different age groups (15-30, 30-45and 45-60) in both genders (male and female) were taken as respondents for the study. By the screening[1] process, six respondents were dropped down from the study due to decline in memory power as well as four were removed out due to inappropriate personal behaviors in sensory evaluation. Selected participants (180) were in good health, and were considered as untrained respondents for consumer panels. All the participants were recruited from a semi urban area of Matara district, Southern province, Sri Lanka.

2.2 Preparation of gustatory stimulants

The stimulants for the sense of gustation were primarily prepared series of salt and sugar solutions (Table 1). Prepared salt and sugar solutions were stored in clean polymer bottles for the subsequent used in the study. Thereafter, these bottles were blind coded with three digits using random numbers in which the samples were distinctly taken.

Table 1 Concentrations of prepared salt and sugar solutions

Sample	Volume of water (cm^3)	Concentration of the Salt/Sugar solution ($moldm^{-1}$)	Weight of Sugar (g)	Weight of Salt (g)
1	1000	0.00	0.000	0.000
2	1000	0.01	3.600	0.585
3	1000	0.08	28.800	4.680
4	1000	0.15	54.000	8.775
5	1000	0.29	104.400	16.965
6	1000	0.43	154.800	25.155

Prepared standard salt/sugar samples (sample 2,3,4,5 and 6) were pared with three reference samples for salt/sugar solution that has decreasing salt levels as it was shown in the table 3.

[1] Screening was done to drop the respondents with inappropriate personal behaviors (smoking, chewing beetle, etc.) who regard as unfitting respondents for sensory analysis.

Table 2: Concentrations of prepared salt/sugar solutions for measuring JND

Solution Series	Reference Solution	Solution samples (Sugar/Salt)				
		2	3	4	5	6
1	0.10	0.43	0.29	0.15	0.08	0.01
2	0.15	0.43	0.29	0.15	0.08	0.01
3	0.20	0.43	0.29	0.15	0.08	0.01

Every solution (both salt and sugar, separately) was paired systematically with its corresponding reference solutions and offered to panelists. Thus, each reference solution had five paired comparison tests keeping the reference solution constant for the five paired sample comparisons.

2.3 Task and procedure

Before attending to the sensory evaluation, each respondent were provided instructions to perform the analysis. A questionnaire was given to each respondent in which responds were collected.

Sensory evaluation was conducted in a calm environment usually from 09.00 to 11.00 am &01.00 to 04.00pm and samples were prepared one hour prior to the evaluation. Panelists were given instructions to perform tasting solution series for salt and sugar separately.

Panelists were allowed to check the samples from the left; sipped the sample from a plastic spoon and kept the sample for 10 seconds in their mouth. Sufficient volume of the solution was provided from the sample and the solution was tasted and spited out the mouth. Mouth was flushed with clean water between each assessment. A gap of 20 s was kept between individual taste assessments to avoid fatigue and adaptation of the tongue.

Every panelist went through 15 comparisons. Then the results are observed and evaluated on the basis of ISO 5495:2005(E) guidelines for sensory evaluation.

2.4 Statistical Analysis

The data obtained from the questionnaire were subjected to analyze statistically. Firstly the data were entered into Microsoft excel worksheet and then transferred into statistical package IBM SPSS Statistical Software version 22.0. The effect of the age and gender for the decline ofthe differential threshold

levels were determined using the multinomial regression model.A significance level of 0.05 was taken into consideration to protect against Type I errors.

According to the number of correct responses or number of persons being able to identify the significant taste differencein given samples, all the significant discrimination responses were used to calculate the Werber's constant.As stated by the ISO 5495:2005 (E), the minimum number of responds required to conclude a significant perceptible difference exists is 20, for 30 respondents [5]. For a significant difference in between the reference sample and the tested sample, number of responds should be ≥ 20. Using significant responds, Werber's constants for each reference samples were calculated and extended into differential threshold levels using equation (1). Calculated differential threshold levels were illustrated graphically for each age group and gender on both gustation types.

3. RESULTS AND DISCUSSION

The effect of differential threshold level by the factors age and gender on the type of taste or the gustation modality is rarely quantified. Since differential threshold level is based on JND, by Werber's law performing a statistical value for the suggested variation was important. Hence, primarily the relationship of the factors, age and gender with the differential threshold level were tested for the linearity of the relationship by using multinomial regression as summarized in the table 3.

Table 3 Outcome of the multinomial regression analysis for two sensory stimuli, sugar and salt

	Differential threshold level	
	Salt	Sugar
Model fitting information (sig. value)	0.149	0.064

According to the obtained sig. value for the model fitting information, applied regression model for the relationship was insignificant (P>0.050); as factors gender and age has no linear correlation with the differential threshold level for two gustations. Although it's not a linear correlation, there can be a relationship between the concerned factors and the differential threshold level.

Differential threshold level is based on the psychological, perceptual behavior pattern of the respondents as its deal with the psychologically perceived intensity of the stimuli [6]. As differential threshold level is bound with cognitive ability of the respondent, variations in the age and gender may effect for the cognitive ability. Some studies have found out the effect of age and gender on sensory thresholds thorough the sensory perception [4]. Hence the study was further examined for the relationship of the effect of age and gender by means of JND value and Werber's constant.

The effect of age and gender towards differential threshold level by means of JND for both gustations were calculated, using equation (1) and represented in the table 4.

Table 4: Calculated JND values and Werber's constants for each age and gender groups

Concentration of the reference sample	Concentration of the solution ($moldm^{-3}$)		Werber's Constant		Differential threshold Level ($moldm^{-3}$)	
	Salt	Sugar	Salt	Sugar	Salt	Sugar
0.10						
• 15-30	0.08	0.08	-0.2	-0.2	-0.02	-0.02
• 30-45	0.15	0.15	0.5	0.5	0.05	0.05
• 45-60	0.29	0.29	1.9	1.9	0.19	0.19
0.15						
• 15-30	0.08	0.08	-0.46	-0.46	-0.07	-0.07
• 30-45	0.08	0.29	-0.46	0.93	-0.07	0.14
• 45-60	0.29	0.29	0.93	0.93	0.14	0.14
0.20						
• 15-30	0.29	0.15	0.45	-0.25	0.09	-0.05
• 30-45	0.43	0.29	1.15	0.45	0.23	0.09
	0.43	0.43	1.15	1.15	0.23	0.23

• 45-60						
0.10						
• Male	0.08	0.15	-0.2	0.5	-0.02	0.05
• Female	0.08	0.08	-0.2	-0.2	-0.02	-0.02
0.15						
• Male	0.29	0.29	0.93	0.93	0.14	0.14
• Female	0.08	0.08	-0.46	-0.46	-0.07	-0.07
0.20						
• Male	0.43	0.43	1.15	1.15	0.23	0.23
• Female	0.15	0.29	-0.25	0.45	-0.05	0.09

According to the results obtained, gustation of salt has shown adecline of the discrimination power or the differential threshold level with the age; however female gender shows lower increment in differential threshold than males. Since differential threshold level is the minimum amount of stimuli change required to discriminate between two stimuli; it's pared with the sensory perception of the respondent. Therefore, changes of the sensory perception occurred with the aging may effect to this sensory loss as magnitude of the difference of the stimulus required for the discrimination against actual threshold level is increased with the aging. Therefore, sensitivity of the respondent can decline along with the aging process[7]. Some researches shows effect of the age is found to act as an attribute in the generic sensory loss as the effect of gender was insignificant [8].

With the ageing, female shows a lesser variation of the differential threshold level compared to males as discrimination power of females might be high. Such effects of gender were reported by several researches; of which they stated that men have higher probability of taste errors than female when recognizing basic tastes [9].It also found that older men are less sensitive towards taste perception for NaCl, sucrose than young men and women [8].

Even within each age group sensory threshold of men were higher than that of female in the same age group [10]. And 20years and onward gender male has higher rate of sensory decline than female [11]. These causes may effect to the higher discrimination power of female than males, reported in the differential threshold level analysis.

Figure 1 and 2 shows the overall variations of the differential threshold level according to the gustation, on the concerning factors; age and gender.

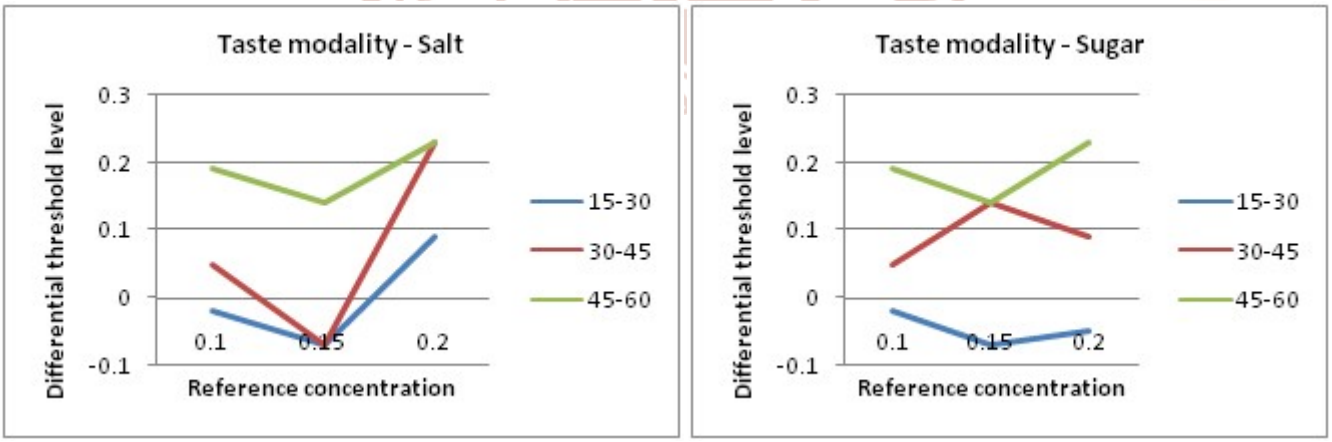

Figure 1 Variation of JND with age groups

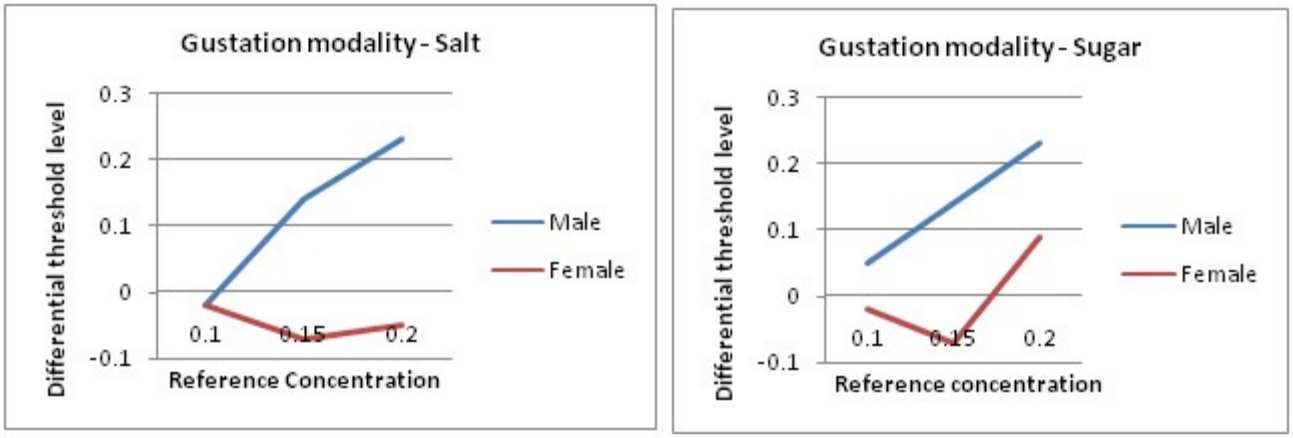

Figure 2 Variation of JND with gender

Cumulative result of the fig. 1 and fig. 2 depict the dependability of the gustation modality with the differential threshold level and the effect of age and gender. Further, sugar taste shows higher JND values with the ageing and gender female has the higher discrimination power with lesser JND values, compared with males. But for the salt gustation both genders has shown lower JND values, and a significant discrimination power of female were observed.

Even some research shows that tastant modality is more interrelated with older ages than for youngers [8]. And it has found that female were more sensitive towards NaCl, cane sugar and quinine [12]. Taste threshold for salt is lower than for sugar might be the reason for this. Some studies has shown that threshold for salt (around 10m*M*) is lower than for sugar (about 20m*M)*[13], as this may cause the found variation of the gender in taste discrimination.

Fig. 1 and fig.2 further shows an increment of differential threshold level with age from 30 years. And gender male has shown positive JND values. But gender female and age below 30 are having negative JND values. It means gender male and ages >30, are capable of discriminate positive concentration gradients, but females and ages <30 are skilled of discriminate negative concentration gradient for both gustations. This is due to the sensory perception, neuropsychological behavior of the respondents.

4. CONCLUSION

Overall study has found; age and gender has no linear correlation with the differential threshold level, but a relationship. As the type of the gustation or the taste modality affects the extent of the differential threshold level, salt is having low JND values compared to the gustation modality; sugar. Gender female was having higher discrimination power of JND values for both tastants than for male in the same age group. Ageing shows a significant increment in the JND values for both tastants, as aging causes decline in discrimination power, differential threshold level.

Further differential threshold level, JND is depending on the gustation modality, and it is declined with the age and has an impact from the gender. The effect of the age towards the JND is improved by the gender female due to the higher discrimination power and lower rate of sensory losses reported by female.

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