An investigation of sensory taste stimuli, the factors that affect them and their potential role in the management of dysphagia.

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Abstract

An investigation of sensory taste stimuli, the factors that affect them and their potential role in the management of dysphagia.

Authors

Eilis O’Brien, Aoife Barden, Blathnайд O’Connor and Arlene McCurtin

Background

In the management of dysphagia, bolus modification is well utilised but sensory bolus modification as a compensatory strategy is not a typical treatment option in clinical practice. This study is a development on Condron et al. (2014) and sets to explore taste stimuli and the association of influencing factors such as intensity, agreeability, time and effort, plus demographic factors such as gender and age with different taste stimuli that may affect sensory taste stimuli use in dysphagia management.

Method

Ethics were approved by UL Ethics Board and participants were recruited via UL internal events email and posters. Participants were blinded during the administration of 14 tastes and each taste was rated on a 9 point hedonic scale for agreeability and intensity and on a binary scale for time and effort. The study was located in the UL Clinical Therapies Clinic and UL Student Union Building.

Results

204 non-dysphagic participants (114 males: 90 females), met the inclusion criteria. This study identified taste stimuli which were high in intensity and agreeabliity e.g. There was a significant positive correlation between agreeability and intensity for Dark Chocolate (rho = 0.222, p < 0.002).

There was a significant positive correlation between agreeability and intensity for the age group 55+ e.g. Mints (rho = 0.774, p< 0.005).
The effect of agreeability on intensity was influenced by age e.g. Rosemary: 35-54 years ($r^2 = +0.86$) vs 55+ years ($r^2 = -0.644$) and Lemon Juice: 35-54 years ($r^2 = -0.444$) vs 55+ years ($r^2 = +0.444$).

The effect of agreeability on intensity was influenced by gender e.g. Dark chocolate: Male ($r^2 = +0.556$) vs Female ($r^2 = -0.04$) and Rosemary: Male ($r^2 = -0.272$) vs Female ($r^2 = +0.86$).

Increased effort was associated with increased transit time e.g. Mints: Increased effort of 83.3% was associated with an increased transit time of 87.7%. Equally, decreased effort was associated with decreased transit time e.g. Tonic Water: decreased effort of 54.4% was associated with ratings of decreased transit time 49.8%.

**Conclusions**

Dark chocolate and mints are taste stimuli which should be considered in the management of dysphagia due to their positive correlations between agreeability and intensity.

**Key words**

*Dysphagia, taste, agreeability, intensity, sensitivity*
Background

Taste Stimuli and the Swallow: What is known about the topic?

The physiological knowledge of the relationship between taste stimuli and the swallow is important. If specific taste stimuli can be found to improve the physiological mechanism of the swallow, these results can be utilised in sensory bolus modification or in other areas for the management of dysphagia.

Different taste stimuli (external chemical and sensory stimuli) stimulate different taste receptors (Steele and Miller 2010). These taste receptors are chemoreceptors and sensory receptors, located on different parts of the tongue. Sensory receptors are responsive to sweet, sour, salty, bitter and umami tastes. Chemoreceptors are responsive to trigeminal (CNV) irritants such as carbonation and citric acid.

By stimulating the chemosensory pathway, an afferent signal is projected via three cranial nerves: facial, glossopharyngeal and vagus, to the brain. In response the brain sends an efferent signal to the oral motor muscles thus generating a swallow response. However, the sensitivity of receptor sites decreases e.g. due to cranial nerve damage and age. This would indicate that in these populations an effective swallow response is not being generated. To increase sensitivity in these populations, taste stimuli that are perceived to be intense should be identified as increased sensitivity levels are associated with decreased incidences of penetration and aspiration (Onofri et al. 2014).

Condron et al. (2014) identified different taste stimuli that were reported as intense and agreeable in a non-dysphagic female population. This study set to explore their reported intensity by administering these taste stimuli to a non-dysphagic population.

What is unknown or problematic?

Sensory bolus enhancement as a form of bolus manipulation is often not implemented in dysphagia management (Martino et al. 2004). In the Irish population, thickening liquids is the preferred bolus modification strategy (McCurtin 2012). Thickened liquids decrease the risk of aspiration (Clavé 2005) but patients often do not meet their daily fluid intake with thickened liquids (Finestone et al. 2001). Furthermore, some authors argue that thickened liquid diets may actually increase pneumonia risk (Logemann et al. 2008). Thus sensory taste enhancement should be explored to examine its
usefulness in the management of dysphagia. However, in the clinical application it is unknown which, if any, sensory taste stimuli will be of benefit in the management of dysphagia. Unfortunately, it can be frequently seen in the literature that even when a taste is identified as intense enough to elicit a swallow response, future studies do not replicate these findings. For instance, Palmer et al. (2005) reported a strong swallow response was reported in a young adult non-dyphagic population when trialed with high intensity taste sour. However, Steele et al. (2012) did not replicate this finding. Other literature shows differences between individual perceptions of agreeability, how much a taste is liked. Chrandrashekar et al. (2009) found participants reported carbonation stimulation as very disagreeable but in contrast participants in the Sdravou et al. (2012) study found direct CO2 stimulation was mostly agreeable. This demonstrates the complexity of taste and its diverse nature across populations.

Ultimately, large discrepancies exist between current studies in the literature assessing the swallow response with different sensory taste stimuli. In this study, an exploration into demographic and other influencing factors that could be contributing to the variable responses towards sensory taste stimuli was carried out.

**Demographic factors**

**Genetics**

People are genetically predisposed to the ‘TAS2R38 gene’. This gene alters our perception of tastes as it varies threshold levels of excitation. Some people need a higher amount of a stimulus to breach a threshold level and excite a neurochemical response. On the other hand, if a stimulus is too intense the person may perceive it as unpalatable. This gene divides people into categories of super tasters, medium tasters and non-tasters (Steele and Miller 2010). It was hypothesised that non-tasters account for 25%, medium tasters account for 50% and super tasters for 25% of the population (Bartoshuk et al. 1994).
Gender

Gender is an important factor to consider for clinical application of sensory bolus modification. Caseloads are frequently mixed gender, and if a gender difference in taste perception exists as suggested by Cohen and Gitman (1959), then the level of excitation of the chemosensory pathway in either gender would be affected differently by different taste stimuli. A study that reported this, showed women have increased threshold levels for bitter tastes when compared to males (Wardwell et al. 2009). This suggests that bitter tastes are not as intense for women as they are for men.

There is also supporting research suggesting that there are differences between gender perceptions of odor. Doty et al. (1985) identified that women are more likely to perform better at identifying taste stimuli by odor regardless of ethnicity or culture. Furthermore, there is a genetic difference between taste perception between women and men. Women are more likely to be super tasters than men regardless of ethnicity and culture (Bartoshuk et al. 1994). However, in stark contrast, Condron et al. (2014) found 75% of Irish female young adult participants were non-tasters but this has yet to be compared to an Irish male population.

In spite of supporting research for gender differences, Mojet et al. (2001) argued there was no significant difference between gender and the perception of tastes but identified that it was taste perception and age, which were significantly correlated.

Age

In the management of dysphagia a typical caseload will consist of elderly patients who are post stroke, have dementia or have head and neck cancer. Aging taste degeneration is suggested to occur at 45 years (Robbins et al. 1992) and is associated with oral and pharyngeal sensitivity decline, which results in taste receptor losses (Prakash and Krishnan 2014). Overall, this means that a decline in receptor sites and a decline in sensitivity will increase the likelihood of aspiration. This is supported by Onofri (2014) who identified decreases in laryngeal sensitivity increased the risk of aspiration.

To combat a decrease in the number of receptor sites for taste stimulation, high levels
of intense taste stimuli are required to activate the remaining receptor sites. This is important since with increased age there are increased excitatory threshold levels in the remaining receptor sites for salt, sour, bitter and umami taste stimuli (Methvan et al. 2012) and sweet taste stimuli (Kennedy et al. 2010). Thus increased sensory enhancement in food is advocated to compensate for sensory loss, which is supported by Schiffman (2000); Prakash and Krishnan (2014).

Neuropsychological Factors

Intensity

Intensity may be defined as how powerful a taste is perceived to be. In the literature powerfulness or intensity of taste stimuli is found to increase when the participant is exposed to higher concentrations of chemosensory stimulants within a taste stimulus. A taste stimulus is considered intense when the chemosensory pathway has been activated and a swallow response has been generated. A strong lingual response would suggest an efficient clearance of the bolus from the oral cavity, which would be as a result of a chemosensory pathway excitation. Previous literature measures the lingual response by lingual pressure or movement, which is related to the intensity of the chemosensory stimulants within a taste stimulus.

Nagy et al. (2014) identified high concentrates of sour, sweet, bitter, salty, all increased lingual pressure compared to lower concentrates. Pelletier and Dhanaraj (2006), also found high concentrates of salt and citric acid increased lingual movement. Carbonation stimulation triggered a strong lingual response indicating carbonation is a highly intense taste stimulus but it was reportedly unpalatable (Chandrashekar et al. 2009). Increased levels of fat increases the intensity of a flavor (Frøst et al. 2002).

From the literature researchers suggest taste stimuli that have higher percentages of sour, sweet, bitter, salty, citric acid and fat components will result in being more intense flavours.

Agreeability

Agreeability may be defined as the likeability of a taste stimulus. Agreeability is often overlooked as an influencing factor for sensory bolus modifications as agreeability does not affect the efficiency of a swallow response since it does not increase lingual
pressure (Pelletier and Dhanaraj (2006); Morishaita et al. (2014)). However, swallowing related cerebral cortical regions were activated when participants were presented with preferred foods (Babaei et al. 2010), which suggests that agreeability is an influencing factor in the activation of a swallow response.

Agreeability also affects compliance rates. Positive compliance rates are crucial in the management of dysphagia as a decrease in compliance will increase the likelihood that a patient will aspirate on non-prescribed food modifications or textures. Increased agreeability rates show a significant correlation with increased compliance rates (Huckabee and Pelletier, 1999)

Some chemosensory stimulants also increase the agreeability of a taste stimulus e.g. adding salt to an already preferred food item increases its agreeability (Yeomans 1998). Interestingly, combinations of umami taste stimuli show significant relationships with agreeability but when a single umami taste stimulus was paired with another taste stimulus this did not increase agreeability (Dermiki et al. 2011).

Throughout the literature bitter tastes and agreeability are not correlated. Studies are more likely to try mask the bitter taste stimulus rather than combining bitter taste stimuli with another taste stimulus to increase agreeability.

**Associations between Intensity and agreeability**

Several studies have been performed in which significant associations between high taste intensity levels and positive agreeability have been found. Nagy et al. (2014) discovered that intense concentrations of salt produced the strongest lingual pressure response and the addition of salt to an already preferred food item increases agreeability (Yeomans 1998).

Similarly, when a high intense taste stimulus (sour) was mixed with a more agreeable taste stimulus (sweet) this combination was reported to produce a strong lingual response and was reported to be positively agreeable in both the young adult and elderly populations (Pelletier and Lawless 2004). However, with this combination (sweet-sour), the effectiveness of the sour taste stimulus was partly suppressed by the sweet taste stimulus when compared to a sour taste stimulus alone.

Furthermore, increased oromotor activity was recorded when cottage cheese (salt-sour
taste stimulus) was paired with a sweet taste and not surprisingly even stronger oromotor activity was produced when a sour taste stimulus was added (Ding et al. 2003).

Time and Effort

Prolonged pharyngeal transit time is a risk factor for aspiration (Bülow et al. 2003) and the timing of lingual duration to clear a bolus is correlated to the effectiveness of the swallow (Lazarus et al. 2000). Perceived effort is under researched in the literature, with most studies focusing on time of lingual movement and pressure. The current study sets to explore time and effort as possible factors that affect sensory taste stimuli.

By identifying factors that influence taste perception we can begin to understand discrepancies within the literature, and furthermore, we can use this specific knowledge to help us manage dysphagia more effectively. By identifying different influencing demographic factors it will help guide clinical judgement as to which dysphagic client group specific taste stimuli should be most effective in.

Objectives:

1) To identify taste stimuli which are i) high in intensity and agreeability ii) low in terms of transit time and effort.

2) To identify if gender or age influences the effect of agreeability on intensity.
Methodology

Ethical Approval and Consent
The Faculty of Education and Health Sciences Research Ethics Committee, in the University of Limerick, approved this study. All participants completed a written consent form before participation. See Appendix (a) for consent form.

Method of recruiting volunteers
Volunteers were classmates in the Speech and Language Therapy program who administered the taste stimuli during the data collection. They were recruited via the Facebook page University of Limerick Speech and Language Therapy. Seventeen volunteers agreed to partake and each volunteer was emailed a detailed summary of the purpose of the study and what their role would be. See Appendix (b). Each volunteer arrived 30 minutes prior to commencing data collection. To ensure consistency, all volunteers who administered tastes stimuli were trained in taste administration and were given scripts to explain to participants about the study’s procedure and rating scales.

Participants
A sample of 204 eligible non-dysphagic male and female participants over 18 years were recruited for this study.

Justification for sample size
25-40 is an adequate sample size for documenting sensory differences for discrimination purposes (Lawless and Heymann 2010).

Method of sampling and recruitment
- Participants were recruited through the University of Limerick Events email which was sent to staff and students. See Appendix (c) for email.
- Posters with basic information about the study were placed one day in advance on poster boards in both the Health Science building (where the data collection was taking place) and the Graduate Entry Medical School (opposite the data collection building). See Appendix (d) for poster.
• Outside of the data collection zone, eligible participants were recruited and provided with oral and written information about the study. See Appendix (e) for leaflet.
Inclusion and Exclusion criteria as shown in table 1

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Explanation</th>
<th>Exclusion Criteria</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Range 18-55+</td>
<td>Used to examine if age influenced taste perception</td>
<td>Smoking history within previous 6 months</td>
<td>Papillary density is lower in smokers which will affect taste perception (Fischer et al. 2013).</td>
</tr>
<tr>
<td>Male and Female</td>
<td>Used to examine if gender influenced taste perception</td>
<td>History of recurrent ear, nose and throat infection or cold/flu on the day of testing</td>
<td>These infections affect taste perception (Mattes et al. 1990).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Food allergies</td>
<td>To avoid anaphylactic Shock.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oral Cavity Diseases/Cranial Nerve Damage (gum disease, xerotomia, oral cancer, cranial nerve damage)</td>
<td>These factors can reduce or block papillae thus reducing sensitivity of taste receptors or result in factors discussed under medications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medications which affect taste</td>
<td>Medications may result in: Dysgeusia (abnormal taste) ageusia (absence of taste) hypogeusia (reduced taste function in any modality).</td>
</tr>
</tbody>
</table>

Table 1: Inclusion and Exclusion Criteria

Withdrawal Criteria

Participants were made aware that they could withdraw from the study at any
Variables

Variables identified in this study are detailed in table 2.

<table>
<thead>
<tr>
<th>Independent</th>
<th>Dependent</th>
<th>Extraneous</th>
<th>Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste stimuli (See table 3)</td>
<td>Gender</td>
<td>TAS2R38 gene which genetically influences our perception of taste</td>
<td>Solid taste stimuli were administered at 1gram</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Culture</td>
<td>Liquids were administered at 1ml</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Loose taste stimuli: Chili powder and rosemary were administered at 1/8th of a teaspoon</td>
</tr>
</tbody>
</table>

Table 2: Description of variables

*Taste stimuli*

This study is a development on Condron et al. (2014). In the previous study the factor analysis identified several taste stimuli that had common features within them and subsequently placed into sensory classification groups. In this study we explore some of the identified taste stimuli which were reported as significantly: i) intense ii) agreeable iii) intense and agreeable iv) bland (control taste stimulus). These taste stimuli are shown in table 3. Pasta was not reported as significant for either agreeability or intensity and acted as a control measure.
The tastes were divided into the following categories:

<table>
<thead>
<tr>
<th>Fragrant and Umami</th>
<th>Fatty/Bland</th>
<th>Additives</th>
<th>Intense Flavours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mints</td>
<td>Hard Meringue</td>
<td>Sparkling water</td>
<td>Tonic water</td>
</tr>
<tr>
<td>Rosemary</td>
<td>Plain Pasta</td>
<td>Vodka</td>
<td>Raw ginger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lemon juice</td>
<td>Mackerel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vinegar</td>
<td>Dark Chocolate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coffee granules</td>
<td>Chili Powder</td>
</tr>
</tbody>
</table>

Table 3: Sensory classifications

**Pilot study**

An in-house pilot study was conducted between the three researchers and 7 classmates to determine the quantities of taste stimuli that should be administered to participants. There is a continued discrepancy between conclusions in studies due to variables not being accounted for. For example, not stating dilute levels so the concentration of the solution is unknown. This present study had a set 1ml protocol liquid taste administration and a 1gram taste administration was agreed upon to ensure consistency and comparability between the taste stimuli. However, in this pilot study the researchers modified the quantity of taste stimuli (rosemary and chilli powder) to 1/8th of a teaspoon as the researchers poorly tolerated both taste stimuli.

**Procedures**

**Data Collection One**

Pre data collection preparation:

1) Each taste was measured to 1g or 1ml and stored in a fridge but all tastes reached room temperature before administration.

2) During preparation the researchers noted chili powder and rosemary as 1gram quantities were not suitable for administration and this was changed to 1/8th of a
teaspoon. A sample model of the amount on a spoon was left for volunteers to copy so this ensured a consistent delivery of administration of these tastes.

3) Sparkling water was prepared during data collection as when left overnight in the syringe, carbonation was found to dissolve.

4) 1ml of Coffee granules was gathered by syringing 1ml from a cup of coffee. The coffee to water ratio in the cup was per manufacturer recommendations for one cup of coffee.

**Procedure**

Participants and volunteers were recruited as mentioned in ‘Methods of Sampling and Recruitment’.

Arrow signs were placed on the walls prior to commencing the study directing participants into the data collection zones. Each station room was numbered. Within each station room rating scale posters were fixed to the wall with a chair facing opposite these scales (See appendix (f)). The tea and coffee room, used for debriefing participants, was also sign posted.

Zone A)

Participants were met by one of the researchers who provided information on the purpose of the study and detailed the eligibility criteria. The researcher also gave each participant a leaflet with written details of the study. See appendix (e) for leaflet. Willing eligible participants were then escorted into Zone B.

Zone B)

Participants were instructed to read and sign the written consent form. See Appendix (a) for consent form. Consenting participants received a response booklet. The cover page contained a form asking for gender identification, date of birth, known allergies, pioneer, vegan or vegetarian. See appendix (g) for cover page from the response booklet. Participants were told not to open the cover page as it was a blinded study.

Zone C)

Participants were escorted to the first tasting room and were instructed to give the
booklet and signed consent form to the first administrator. The administrator read the cover page of the booklet and orally asked the participant all the questions on the cover page. Participants were reminded there were three stations to complete and to bring their booklet with them to each station. Administrators wore disposable aprons and disposable gloves. Participants were directed to sit facing a wall where rating scales had been attached. The administrator explained the rating scales to the participant. Participants were directed to close their eyes before and during administration of the taste and reopen their eyes when pointing to the rating scale. Participants were directed to drink water before and in-between each taste to clean the oral cavity. Solid food tastes were administered via spoon and liquids via a syringe. Participants were asked if they wanted to administer the taste themselves with their eyes closed or if they would like the administrator to deliver the taste. Participants were made aware of spittoons, tissues and bins and were reminded to take a break if they needed to.

On completing the last station, participants submitted their response booklet and were directed to Zone D.

Zone D)/Debriefing Zone
Tea, coffee and biscuits were provided for all participants. A member of the researching team was also present at this point to answer any questions the participant may have had at the end of the study. During this debriefing session participants shared their experience, from this qualitative data was gathered.

Data Collection 2

Day two of data collection was conducted in the Students Union building on the day of the farmers market as the researchers felt there would be an older population in this location within the University grounds.

Only one room was available in the Student’s Union building. This room was divided into three zone areas. Each participant had roughly two meters gap between them and researchers stood in-between this space blocking other participant’s facial reactions.
Statistical Analysis

All participants rated taste stimuli on a 9 point hedonic scale, for agreeability and intensity, which is the most widely used rating scale for measuring taste stimuli. The hedonic scale for agreeability is shown in table 4.

<table>
<thead>
<tr>
<th>Absolutely hate it</th>
<th>Dislike it very much</th>
<th>Dislike it moderately</th>
<th>Dislike it slightly</th>
<th>Neither like nor dislike</th>
<th>Like it slightly</th>
<th>Like it moderately</th>
<th>Like it very much</th>
<th>Absolutely Love it</th>
</tr>
</thead>
</table>

Table 4: Rating scale for agreeability.

Binary scales were used to rate time, effort and agreeability as shown in table 6.

<table>
<thead>
<tr>
<th>Less time</th>
<th>More time</th>
<th>Less effort</th>
<th>More effort</th>
<th>You would eat this taste again</th>
<th>You would not eat this taste again</th>
</tr>
</thead>
</table>

Table 5: Binary scales for time, effort and acceptability.
All responses were coded into The Statistical Package for the Social Sciences (SPSS, IBM). The following statistical tests, shown in table 6, were employed to analyse the data. From this analysis, scatterplots, tables and charts were used to summarise data found.

<table>
<thead>
<tr>
<th>Statistical Analysis</th>
<th>What was tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolmogrov-Smirnov and Sharipo Wilik</td>
<td>Test for normality in age and gender.</td>
</tr>
<tr>
<td>Descriptive statistics</td>
<td>Test for frequency trends: Identified trends in intensity, agreeability, time,</td>
</tr>
<tr>
<td></td>
<td>effort and acceptability.</td>
</tr>
<tr>
<td>Simple regression analysis</td>
<td>To identify the positive/negative effect of agreeability on intensity. Positive</td>
</tr>
<tr>
<td></td>
<td>effect shows agreeability positively affects intensity scores.</td>
</tr>
<tr>
<td>Spearman’s Rho</td>
<td>The scores were markedly skewed thus part of Pearson’s criteria was not met</td>
</tr>
<tr>
<td></td>
<td>(Howitt and Cramer 2008). This test indicates the strength and direction of a</td>
</tr>
<tr>
<td></td>
<td>relationship between two variables (Howitt and Cramer 2008)</td>
</tr>
</tbody>
</table>

Table 6: Statistical Analysis

Statistical significance was achieved when:

- \( r^2 = +0.2 \)
- The critical alpha probability (p) value at which relationships were considered to be statistically significant at \( p < 0.05 \).
Analysis of the Results

Demographics

Normality and Age

A Sharipo-Wilk tests for normality tested for normality distributions. A Kolmogrov-Smirnov analyzed the distribution of the variables age and gender. Age was not normally distributed with a median of age of 23. See figure 1.

![Histogram](image1)

**Figure 1: Distribution of age**

Normality and gender

Gender was more evenly distributed, 144 male: 90 female. See figure 2.

![Pie chart](image2)

**Figure 2: Gender ratio**
Gender distributions in age groups

Figure 3 shows the distribution of the number of participants in each age group for both gender groups.

Figure 3: Number of male and female participants in age groups
Neuropsychological Factors

Intensity frequency percentage trends

Figure 4 shows the frequency percentage trend of intensity ratings.

Agreeability frequency percentage trends

Figure 5 shows the frequency percentage trend of agreeability ratings.

Figure 4: Intensity frequency percentage trend

Figure 5: Agreeability Frequency percentage trend
**Intensity and Agreeability Frequency Percentage trends**

Figure 6 shows the frequency trend percentages of both perceived agreeability and intensity of taste stimuli. Figure 6 shows that Mints, Dark Chocolate, Hard Meringue, Mackerel and Tonic Water are suggested to have high positive percentage trends in both agreeability and intensity. This would suggest these stimuli are eligible for further investigation. The effect of agreeability on intensity and the significance strength and direction level of their relationship were explored.

![Graph showing percentage of participant’s ratings of Intensity and Agreeability](image)

**Figure 6: Percentage of participant’s ratings of Intensity and Agreeability**
**Correlations between intensity and agreeability**

Spearman’s Rho tested for significant relationships between intensity and agreeability. Table 7 shows a significant positive relationship between intensity and agreeability for both mints and dark chocolate.

<table>
<thead>
<tr>
<th>Taste</th>
<th>Analysis from Spearman’s Rho (Significance levels at p&lt;.05)</th>
<th>Significance level of relationship between agreeability and intensity</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mints</td>
<td>Relationship between intensity and agreeability</td>
<td>(rho= 0.173, p &lt; 0.014)</td>
<td>Significant positive correlation</td>
</tr>
<tr>
<td>Dark Chocolate</td>
<td>Relationship between intensity and agreeability</td>
<td>(rho= 0.222, p &lt; 0.002)</td>
<td>Significant positive correlation</td>
</tr>
<tr>
<td>Hard Meringue</td>
<td>Relationship between intensity and agreeability</td>
<td>(rho= 0.025, p &gt; 0.05)</td>
<td>No significant correlation</td>
</tr>
<tr>
<td>Mackerel</td>
<td>Relationship between intensity and agreeability</td>
<td>(rho= -0.194, p &lt; 0.007)</td>
<td>Significant negative correlation</td>
</tr>
<tr>
<td>Tonic Water</td>
<td>Relationship between intensity and agreeability</td>
<td>(rho= -0.092, p &gt; 0.05)</td>
<td>No significant correlation</td>
</tr>
</tbody>
</table>

Table 7: Statistical analysis results from Spearman’s Rho

Following this a simple regression analysis identified there was a positive effect of agreeability on intensity for both dark chocolate ($r^2 = 0.017$) and mints ($r^2 = 0.032$).
**Effect of Time and Effort**

Intensity increases oral transit time and effort required for manipulation. Agreeability does not increase or reduce oral transit time or effort needed. The frequency trend suggests the taste stimuli presented in figure 7, require more mastication effort and had longer transition times from the oral phase to the pharyngeal phase all of these taste stimuli had high intensity percentage ratings.

![Figure 7: Taste stimuli with more effort and time](image)

The frequency trend suggests, see figure 8, that sparkling water and tonic water require the least mastication effort and have a shorter transit time from the oral phase to the pharyngeal phase when compared to all other taste stimuli.

![Figure 8: Taste stimuli with less effort and time](image)
Acceptability

Participants were asked if they would eat this taste again and a frequency percentage trend as shown in figure 9 suggests <50% of participants would eat the high intensity taste stimuli of lemon juice, chili powder, vodka, coffee granules, vinegar, rosemary and raw ginger.

![Figure 9: Frequency percentage trend of acceptability](image)

The findings of intensity, agreeability, time, effort and acceptability have been reported. Dark chocolate and mints are the two taste stimuli which have the strongest positive relationships between agreeability and intensity. The effect of agreeability on intensity for these taste stimuli is also positive. In the next section these taste stimuli will be further examined with the factors of time, effort and acceptability.
**Effect of Time and Effort on mints and dark chocolate**

Transit time refers to the amount of time a bolus needs to pass from the preparatory phase to the end of the pharyngeal phase. Effort refers to the required strength and movement required to manipulate a bolus. The percentage frequency trend in Figure 10 suggests dark chocolate was less effort to manipulate in the preparatory phase whilst it is suggested that mints required more effort to manipulate the taste stimuli.

![Figure 10: Percieved effort required for Dark Chocolate and Mints](image)

In Figure 11, the frequency percentage trend suggests dark chocolate took less transitioning time from the oral phase into the pharyngeal phase. In contrast mints are suggested to take more time to transition from the oral phase to the pharyngeal phase.

![Figure 11: Percieved time of Dark Chocolate and Mints](image)
**Acceptability:**

The frequency trend suggests both tastes would be eaten again by over 90% of participants as shown in figure 12.

![Figure 12: Acceptability rates](image-url)
The Effect of Age on Taste Perception

Table 8 shows the effect of agreeability on intensity. A positive effect shows higher agreeability rates influence higher intensity rates. A negative effect shows higher agreeability rates influence negatively on intensity rates thus intensity perception is lower. Age does significantly influence the following taste stimuli: Rosemary, Pasta and Lemon Juice. In the (35-54) age group, agreeability affected intensity positively and the opposite was found in the (55+) age group. However, this was with the exception of lemon juice.

<table>
<thead>
<tr>
<th>Taste</th>
<th>Simple regression on age</th>
<th>Effect of agreeability on intensity</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosemary</td>
<td>Female (35-54)</td>
<td>(r^2 = 0.86)</td>
<td>Strong positive effect</td>
</tr>
<tr>
<td></td>
<td>Female (55+)</td>
<td>(r^2 = -0.644)</td>
<td>Strong negative effect</td>
</tr>
<tr>
<td>Pasta</td>
<td>Female (35-54)</td>
<td>(r^2 = 0.424)</td>
<td>Positive effect</td>
</tr>
<tr>
<td></td>
<td>Female (55+)</td>
<td>(r^2 = -0.213)</td>
<td>Weak negative effect</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>Male (35-54)</td>
<td>(r^2 = -0.444)</td>
<td>Negative effect</td>
</tr>
<tr>
<td></td>
<td>Male (55+)</td>
<td>(r^2 = 0.444)</td>
<td>Positive effect</td>
</tr>
</tbody>
</table>

Table 8: Effect of agreeability and intensity influenced by age
The Effect of Gender on Taste Perception

Table 9 shows the effect of gender on taste perception. A gender difference was most significant for the follow taste stimuli as shown in table 9. A gender difference was most apparent in the 35-54 and 55+ age groups.

<table>
<thead>
<tr>
<th>Taste</th>
<th>Simple regression on gender</th>
<th>Effect of agreeability on intensity</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Chocolate</td>
<td>Male (55+)</td>
<td>( r^2 = 0.556 )</td>
<td>Strong positive effect</td>
</tr>
<tr>
<td></td>
<td>Female (55+)</td>
<td>( r^2 = -0.041 )</td>
<td>Weak negative effect</td>
</tr>
<tr>
<td>Rosemary</td>
<td>Male (35-54)</td>
<td>( r^2 = -0.272 )</td>
<td>Weak negative effect</td>
</tr>
<tr>
<td></td>
<td>Female (35-54)</td>
<td>( r^2 = 0.86 )</td>
<td>Strong positive effect</td>
</tr>
<tr>
<td>Pasta</td>
<td>Male (55+)</td>
<td>( r^2 = 0.617 )</td>
<td>Strong positive effect</td>
</tr>
<tr>
<td></td>
<td>Female (55+)</td>
<td>( r^2 = -0.213 )</td>
<td>Weak negative effect</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>Male (55+)</td>
<td>( r^2 = 0.444 )</td>
<td>Positive effect</td>
</tr>
<tr>
<td></td>
<td>Female (55+)</td>
<td>( r^2 = -0.780 )</td>
<td>Strong negative effect</td>
</tr>
</tbody>
</table>

Table 9: Effect of agreeability on intensity influenced by gender
**DISCUSSION**

The demographic factors of age and gender do alter the effect of agreeability on intensity. High intensity taste stimuli were generally related to longer transit times and required more effort to manipulate but this was not always the case. Agreeability did not have any effect on oral transit times or effort needed to manipulate a bolus. A lot of taste stimuli were not significant for agreeability and intensity. Significant negative results between intensity and agreeability show some taste stimuli alone are not suitable for sensory bolus enhancement but future studies should explore taste stimuli pairings.

Most importantly this study has identified two taste stimuli for exploration in a clinical setting. Figure 13 shows the two taste stimuli that could be used in the management of dysphagia: Mints and Dark Chocolate.

![Figure 13: Summary of Mint and Dark Chocolate](image)

Reportedly, over 90% of participants would eat both of these taste stimuli again. However, mints required more effort to manipulate and required longer oral transit times. In contrast, dark chocolate was found to have lower transit times and required less effort to manipulate. Thus dark chocolate meets the most criteria to use as a taste stimulus in sensory bolus manipulation in the management of dysphagia.

Mints should not be totally disregarded however. The mints used in this study had a hard outer shell with a chewy inside. If the mints were administered not as a solid but rather as a liquid this might decrease oral transition time and less manipulation effort
would be required. This is only speculative as the general trend suggests that despite the format a bolus is delivered in, increased intensity equates to increased transit times and increased effort e.g. the liquid taste stimulus vinegar. However, mints had a reported high positive agreeability rating, which then might be associated with a decrease in effort and oral transit time if delivered in a liquid format. Thus the effectiveness of mints as a liquid could be investigated for clinical application use in dysphagia management.

**Time and effort**

Sparkling water was a taste stimuli which was rated as having the fastest transit time which is in line with previous research (Chandrashekar et al. 2009). Sparkling water also required the least effort to swallow. This would suggest that if mints were delivered in a carbonated liquid format this would further decrease oral transit time and effort required.

Participants rated time and effort on a binary scale and descriptive statistics utilised a frequency trend to suggest their percentage rating levels. However, no statistical analysis examined if there was a correlation between time and effort. It appears from the results that an increase in oral transit time is related to more effort needed for bolus manipulation and in general this is associated with higher intensity tastes. Future studies should investigate the correlation between these factors. Interestingly it would have been presumed that liquids would take less effort and oral transit time, as is the case for sparkling water and tonic water, but this was not demonstrated for vinegar. This further supports intensity’s role as a factor in influencing oral transit time and manipulation effort.

**Demographic factors**

This study supports that age and gender do influence the effect of agreeability on intensity, which is in line with previous literature discussed in the background. In this study most notably, age influenced the effect of agreeability on intensity between the age groups of 35-54 versus 55+ using the taste stimuli of rosemary, lemon juice and pasta. Gender groups were shown to influence the effect of agreeability on intensity using the taste stimuli of dark chocolate, rosemary, lemon juice and pasta.
This study has not identified which demographic factor has the greater influence on taste stimulus perception, thus it is unknown from this study if it supports Mojet et al. (2001) theory that age influences the perception of taste. Likewise, it is uncertain whether it supports Wiffenbach et al. (1982) theory that gender accounts for the discrepancies between taste stimuli perceptions. This is especially true since there were a lot of taste stimuli that did not demonstrate age and gender influences. Possible reasons for this include i) some taste stimuli were not significant at all ii) both gender groups equally disliked or liked a taste stimulus iii) both gender groups found the taste stimulus to be intense.

The 18-34 age group was the most representative sample as it had the highest number of participants but no significant findings or discrepancies between gender were found in this age group. This suggests that with increased age, the discrepancy between gender groups becomes more evident and a more influential factor on the effect of agreeability on intensity and their relationship. Future studies should consider exploring why gender differences become more obvious as we age.

Another hypothesis that could be formed is that this age group is more exposed to higher intensity taste stimuli in their daily diet, such as alcohol and coffee, in comparison to older participants which could be increasing the threshold for excitation in this younger population. Thus in the 18-34 age group they would need higher intensities of taste stimuli to generate an oromotor response. This then opens future research to investigate diet as another influencing factor on intensity and agreeability.

Major patterns and unexpected findings
The results show that Male participants aged 55+ preferred sweeter bitter tastes such as mints, lemon juice and dark chocolate, which is in contrast to the female participants in this age group who had negative effects of agreeability on intensity associated to bitter taste stimuli. Previous literature suggested that females have higher threshold levels for bitter taste stimuli (Wardwell et al. 2009) and so they would be less sensitive to the bitter taste stimuli, find it less intense and maybe more agreeable but this was not identified in this study.

Carbonated water was rated within the weak rating scale, which in contrast to previous literature (Nixon et al. (1997); Morishita et al. (2014)). The reason for this
could have resulted from the carbonated water being in a jug on the day of testing, with de-carbonation occurring as the day progressed.

Higher intensity tastes were associated with increased levels of effort and time, which is in contrast to previous literature which supports increased lingual movement and thus a decrease in oral transit time when using higher intensity taste stimuli (Pelletier and Dhanaraj (2006); Pelletier and Steele (2014)).

Qualitatively five participants reported that vodka alone was too intense and not agreeable but explained they liked vodka when combined with another taste such as lemon. Similarly, two participants reported they liked the taste of vinegar with salt and chips but vinegar alone was very disagreeable.

The factor of thermal effects were not explored in this study but should be considered in future studies. All tastes were delivered at room temperature which may have affected the agreeability of taste stimuli. Qualitatively, for the taste stimuli coffee, many participants reported they did not like this taste but reported that they usually liked hot and iced coffee.

With hot coffee it is usually accompanied by milk and in iced coffee they often have cream. The combination of a fatty taste stimuli with the coffee might further increase the agreeability of coffee. Since higher levels of fat allow for a slower release of flavour (Frøst et al. 2005) participants may prefer that combination compared to what was administered in this study i.e. straight black coffee without milk or cream.

Results which have been found to be agreeable but were not significant in terms of intensity could be used in the clinical environment by

i) **Dieticians**: Oral nutritional supplements like that of high calorie drinks are often disliked by patients (Gosney 2003) and thus compliance rates are poor (Methven et al. 2012). To increase agreeability, taste stimuli such as dark chocolate or mint could be added to these supplements and regular foods to encourage consumption.
ii) **Speech and Language Therapists:** Specific sensory taste stimuli should be i) added to thickeners to enhance flavour ii) used to provide increased oral sensory feedback in elderly or post stroke populations iii) used as a form of swallowing preparation before a meal and to provide sensory feedback in older populations.

**Limitations**
The age ranges of participants were unequally distributed which may have affected the sensitivity of the statistical analysis. The answers from 35-54 and 55+ age groups would not be representative of the whole population but should still be considered because of their significance levels. Further research should include more participants in the 35-54 and 55+ age groups.

Different cultural backgrounds were not explored. Different cultures have different cuisines and these cuisines often have varied taste stimuli. For instance, the Indian cuisine would include high intensity stimuli like spices or ginger in the everyday diet. This could result in an increased threshold level of excitation for taste receptors in this population. Similarly, the younger age group 18-34 years may be exposed to a more varied cuisine compared to the older age groups, which may also be contributing to the result that the 18-34 age group did not show any significant results in taste perception differences.

Future analysis should explore other factors like diet and over consumption of high intensity taste stimuli and this might explain why there were no significant results found in the 18-34 age group.

Other significant intense and agreeable taste stimuli should be investigated from the Condron et al. (2014) study, as originally 33 taste stimuli were going to be administrated but due to time constraints presented this was narrowed to the administration of 14 taste stimuli.

The relationship between gender / age with time and effort were not analysed which could have been an influencing factor on the results of time and effort and this should be explored in future studies.
The measurements of effort and time were subjective. Lingual pressure palates would accurately show the oromotor activity required and a timer could have been used to record the timing between entering the oral cavity until a swallow was completed. Using these instruments it would have ensured a more objective result for time and effort.

Effort and time were only analysed using frequency trends and no correlational test was used. It would have been more significant to identify the strength and direction of the relationship between effort and time.

Previous literature identified that some taste combinations, (sweet-sour) can increase agreeability but decrease the intensity of that taste (Pelletier and Lawless 2004). Future research should explore taste combinations by including this study's taste stimuli, which were mostly intense and combine them with agreeable taste stimuli. For example: ginger and chocolate, pairings of additives such as lemon and vodka (which qualitatively several participants reported as a more agreeable taste combination), or pairings of mackerel (salty) and chili powder, since salt increases agreeability (Yeomans 1998).

This study did not focus on odour as an influencing factor. Previous literature suggests that odour generates a faster swallow response (Ebihara et al. 2006). Future studies should examine the influence the factor of odour on taste stimuli.

During the data collection, it was reported that when high intensity taste stimuli preceeded the administration of a lower intensity stimuli it influenced the ratings of the lower intensity taste stimuli. This was controlled for by asking participants to drink water inbetween each taste stimuli but a longer time period between taste stimuli should have been addressed or rearranging the delivery process of taste stimuli to include higher intensity taste stimuli at the end of the station should have been organised.

Thermal energy has been identified as an influencing factor in sweet taste stimuli (Talavera et al. 2005). This study did not account for the effects of thermal energy in relation to agreeability and intensity in taste stimuli. Many people disliked room
temperature tastes on intensity and agreeability, which may have affected intensity and agreeability effects. Future studies should explore the effect of thermal energy on intensity and agreeability of taste stimuli.

From this study we have discovered two taste stimuli, mint and dark chocolate, that could be used for sensory bolus manipulation in dysphagia management. This paper has also identified taste stimuli that are high in intensity but are disagreeable making them less suitable for use in dysphagia management.

**Conclusion**

This paper explored the factors of age, gender, intensity, agreeability, time and effort. Based on this study’s findings, these factors must be considered when using sensory taste bolus modification in dysphagia management. The properties of dark chocolate and mints should be considered in particular as these tastes were generally found to be more intense and agreeable. Moreover >90% of participants said they would try these taste stimuli again. If used in a liquid format both of these taste stimuli might show a decrease in oral transit time and effort. Therefore, future studies should investigate the effectiveness of mint and dark chocolate in clinical populations. Ultimately, mint and dark chocolate properties show strong significant positive correlations between intensity and agreeability. Since these factors are believed to be associated with an effective swallow response, if delivered in the appropriate format, these sensory taste stimuli could play an important role in dysphagia management in the future.
References:


High and Low Concentration Taste Stimuli’, *BioMed research international, 2014.*


CONSENT FORM

TASTE STUDY

PURPOSE OF THE STUDY

This study aims to gain a clearer understanding about how you perceive specific tastes and how these tastes trigger your swallow.

(Also known as: The identification of intensity, agreeability and perceived time and effort of the sensory and chemesthetic properties of selected taste stimuli among non-dysphagic populations.)

I ……………………………………………………………………………………………………………………………………………………………………………………………………………… (Please Print Name) give my consent to take part in the above study

I understand my data will be anonymised

I do not have any known food or nut allergies

I am aware of the potential risks

I understand I can discontinue my participation at any point during the study

Signed ………………………………………….. Date………………………………………..

Any questions or concerns. Please contact the Principal Research Dr Arlene McCurtin on 061 234180, Arlene.mccurtin@ul.ie

This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee (2013_10_08_ EHS). If you have any concerns about this study and wish to contact someone independent you may contact: Chairman, Education and Health Sciences Research Ethics Committee, EHS Faculty Office, University of Limerick, Tel 00 353 (061) 234101.

Appendix: (a) Consent form
Appendix: (b) Information forms for Volunteers

Final Year Research Project: Volunteer Education and Information

Title of Research Project: The identification of intensity, agreeability and perceived time and effort of the sensory and chemesthetic properties of selected taste stimuli among non-dysphagic populations.

Principal Investigator: Arlene McCurtin

Other Investigators: Aoife Barden, Blathnaid O’Connor, Eilis O’Brien

Aims of the study:

- To identify the agreeability, intensity and perceived impact of selected sensory and chemesthetic tastes.
- To examine associations between age, gender and intensity, agreeability and impact ratings for tastes.
- To develop a scale of tastes that will aid in the management of dysphagia.

Research collection dates/times:

- **Tuesday 10th February** from 10am-6pm (*Speech and Language Therapy Clinic, Health Science Building*)

and

- **Tuesday 17th February** drop in anytime from 10am-6pm (*Students’ Union Room 3 (Upstairs]*)

What we will need you as a volunteer to do:

We have a number of zones to cover throughout both research days:

- A meet and greet area (Zone A) outside each testing room will provide participants with an information sheet, allow them to ask any questions and provide individuals with an option to participate or withdraw prior to proceeding to the data collection area. Participants will be asked if they have any food or nut allergies at this point. Participants with allergies to foods or nuts will not be able to participate, this is for participant safety. Other exclusionary criteria for the study is also outlined on the information sheet which participants must be made aware of. Participants that are meet any exclusionary criteria may not participate in the study.

- Participants will be directed to Zone B – where consent will be obtained in a written format. Consent forms must be filled out before beginning. Participants will then be given their response booklets and must also fill in the cover page. Ensure participants do not turn over the cover page.
Participants will then move to Zone C where data will be collected. Data collection will be split into 3 stations so individual participants will not be influenced by other participants reactions/ratings. Each station will feature a number taste stimuli. Participants will be required to taste and rate the stimuli (14 taste stimuli in total). Once they have completed all stimuli within each station participants will move from to the other stations; under the direction of a student researcher. The student researcher will put on disposable gloves and apron.

**At each station:**

Take the booklet from the participator and begin the tasting. It is important that you fill out all sections of the booklet when the participant gives you their response. Ask each participant to close their eyes prior to tasting each item to reduce the confounding effect of visual cues. Participants will feed themselves the samples. Make participants aware as to whether they will be receiving a syringe or spoon and when you will be handing it to them. After each taste **you must tell the participants take a drink of water to cleanse /neutralise the palate.** Once all sections are completed for that booth and the tastes, **you must close** the booklet and hand it back to the participator and direct them to the next booth. It is important the participator does not open the booklet as this is a blinded study. Dispose of your gloves **after each participant in a hygiene bin at the side of the station.**

At Zone D participants will be offered coffee/tea and a biscuit at the end of tasting.

**Volunteers will be asked to help out at:**

- Zone A, B, C, D

**Any questions/queries please contact:**
Aoife Barden: 08-
Blathnaid O’Connor: 08-
Eilis O’Brien: 08-

*Thank you for your time and help; Aoife, Blathnaid and Eilis*
Appendix: (c) Recruitment email

We are looking for participants for a taste study!

So what do you have to do??

We want you to rate a variety of taste samples on scales of intensity and agreeability and tell us if it takes more or less time than normal in terms of time and effort. This will help aid in the identification of taste stimuli for the management of clinical populations with eating, drinking and swallowing disorders. We appreciate your help.

So come to the Speech and Language Therapy Clinic, Health Science Building (ground
floor, across from GEMS building) from 10am-6pm on Tuesday 10\textsuperscript{th} February and get your taste on!!
Afterwards you can get a tea/coffee and a biscuit!

Please note you can only participate IF you are over 18, a non-smoker for at least 6 months, do not have any food or nut allergies or a history of ear, nose and throat problems, are not taking medication that will impact on your sense of taste or smell or have a diagnosed sensory problem relating to taste or smell, do not have any swallowing difficulties, coughs, colds or respiratory infection on the day in question then we would appreciate your help in our study about taste...

\textit{This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee (2013\_10\_08\_ EHS). If you have any concerns about this study and wish to contact someone independent you may contact: Chairman, Education and Health Sciences Research Ethics Committee, EHS Faculty Office, University of Limerick, Tel 00 353 (061) 234101}
Come and tell us what you think of different tastes!
We are MSc students looking for participants for a taste study.
We will ask you to try a variety of taste samples then tell us what you think of them.
Afterwards you can have tea/coffee and a biscuit.
If you are over 18, a non-smoker for at least 6 months, do not have any food or nut allergies or a history of ear, nose and throat problems, are not taking medication that will impact on your sense of taste or smell or have a diagnosed sensory problem relating to taste or smell, do not have any swallowing difficulties, coughs, colds or respiratory infection on the day in question then we would appreciate your help in our study about taste...
Interested? Then please come to the _______ anytime on the ________
How people perceive different tastes and how these tastes trigger your swallow.

Study Information Sheet

The purpose of this information sheet is to give you the details about our study so you can make an informed decision about whether you would like to participate or not.

What is this study about?
This study aims to gain a clearer understanding about how you perceive specific tastes and how these tastes trigger your swallow.

Who can participate?
To participate you must;

| • Be Over 18 | • Be a non-smoker of at least 6 months duration |
| • Have no prior swallowing difficulties/history of Ear Nose and Throat problems including oral surgeries | • Not be on medication that will impact your sense of taste or smell or have diagnosed sensory problems relating to taste or smell |
| • Not currently have a cough, cold, allergic or respiratory infection | Not have diagnosed sensory problems related to smell and taste including |

• NOT HAVE ANY FOOD/NUT ALLERGIES

What do we want to find out?
We want you to rate a variety of taste samples on scales of intensity and agreeability and tell us if the take more or less time than normal in terms of time and effort. This will help aid in the identification of taste stimuli for the management of clinical populations with eating, drinking and swallowing disorders. We appreciate your help.

What is involved?
• You will be asked to sign a consent form

• You will be directed to the first of 4 tasting stations
• Then you will be asked to put on an apron.

• At each station you will be offered a number of food tastes. You will be asked to close your eyes before each taste. The researcher will place the tasting item on your tongue. After each taste you will be asked to take a sip of water to cleanse your mouth.

• After each taste you be asked to use the scales on the table in front of you to evaluate each taste for intensity, agreeability, time and effort.

• At the end of each station you will dispose of your cup in the bin provided. At the end of the 4 stations when tasting is complete, you will dispose of the apron in the bin provided.
• Tea/Coffee and biscuits will be available to help cleanse the palate.

So what’s next??
If you are happy to participate in our study, please sign the consent form and proceed into the data collection zone.

Any questions or concerns. Please contact the Principal Research Dr Arlene McCurtin on 061 234180, Arlene.mccurtin@ul.ie

This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee (2013_10_08_ EHS). If you have any concerns about this study and wish to contact someone independent you may contact: Chairman, Education and Health Sciences Research Ethics Committee, EHS Faculty Office, University of Limerick, Tel 00 353 (061) 234101
Appendix: (f) Rating scales

PARTICIPANT RATING SCALES

RATING SCALE 1 – AGREEABILITY
Now that you have tasted that taste, look at the scale for agreeability in front of you. How would you rate the taste you have just tried using this scale?

<table>
<thead>
<tr>
<th>Rating Scale 1</th>
<th>Absolutely hate it</th>
<th>Dislike it very much</th>
<th>Dislike it moderately</th>
<th>Dislike it slightly</th>
<th>Neither like nor dislike it</th>
<th>Like it slightly</th>
<th>Like it Moderately</th>
<th>Like it Very Much</th>
<th>Absolutely love it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image" alt="Hate" /></td>
<td><img src="image" alt="Dislike" /></td>
<td><img src="image" alt="Dislike" /></td>
<td><img src="image" alt="Dislike" /></td>
<td><img src="image" alt="Neither" /></td>
<td><img src="image" alt="Like" /></td>
<td><img src="image" alt="Like" /></td>
<td><img src="image" alt="Like" /></td>
<td><img src="image" alt="Love" /></td>
</tr>
</tbody>
</table>

RATING SCALE 2 - INTENSITY
Look at this scale for intensity. How would you rate the taste you have just tried using this scale?

<table>
<thead>
<tr>
<th>Rating Scale 2</th>
<th>Extremely weak and insubstantial</th>
<th>Very weak and insubstantial</th>
<th>Moderately weak and insubstantial</th>
<th>Mildly weak and insubstantial</th>
<th>Neither weak nor strong</th>
<th>Slightly strong and powerful</th>
<th>Moderately strong and powerful</th>
<th>Very strong and powerful</th>
<th>Extremely strong and powerful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image" alt="Extremely Weak" /></td>
<td><img src="image" alt="Very Weak" /></td>
<td><img src="image" alt="Moderately Weak" /></td>
<td><img src="image" alt="Mildly Weak" /></td>
<td><img src="image" alt="Neither" /></td>
<td><img src="image" alt="Slightly Strong" /></td>
<td><img src="image" alt="Moderately Strong" /></td>
<td><img src="image" alt="Very Strong" /></td>
<td><img src="image" alt="Extremely Strong" /></td>
</tr>
</tbody>
</table>

53
RATING SCALE 3 – EFFORT
Did it take less or more effort for you to swallow this taste sample?

<table>
<thead>
<tr>
<th>Less effort</th>
<th>No difference</th>
<th>More effort</th>
</tr>
</thead>
</table>

RATING SCALE 4 – TIME
Did it take you less or more time to swallow this taste sample?

<table>
<thead>
<tr>
<th>Less time</th>
<th>No difference</th>
<th>More time</th>
</tr>
</thead>
</table>

RATING SCALE 5 – ACCEPTABILITY
Considering all the scales above would you eat this?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>
Appendix: (g) Cover page of response booklet and response booklet

TASTE STUDY
This study aims to gain a clearer understanding about how you perceive specific tastes and how these tastes trigger your swallow.

(A also known as: The identification of intensity, agreeability and perceived time and effort of the sensory and chemesthetic properties of selected taste stimuli among non-dysphagic populations.)

Tick box or fill in as appropriate;

Male [ ] Female [ ] Date of Birth ______________________

Pioneer Yes [ ] No [ ]

Vegetarian Yes [ ] No [ ]

Vegan Yes [ ] No [ ]

Room 1_______
Room 2_______
Room 3_______

Please DO NOT turn over this page
### Room 1 Fragrant/Unami

**RATING SCALE 1 – AGREEABILITY**  
*Now that you have tasted that taste, look at the scale for agreeability in front of you. How would you rate the taste you have just tried using this scale?*

<table>
<thead>
<tr>
<th></th>
<th>Absolutely hate it</th>
<th>Dislike it very much</th>
<th>Dislike it moderately</th>
<th>Dislike it slightly</th>
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<th>Like it Moderately</th>
<th>Like it Very Much</th>
<th>Absolutely love it</th>
</tr>
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<tbody>
<tr>
<td>Mint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosemary</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RATING SCALE 2 – INTENSITY**  
*Look at this scale for intensity. How would you rate the taste you have just tried using this scale?*

<table>
<thead>
<tr>
<th></th>
<th>extremely weak and insubstantial</th>
<th>very weak and insubstantial</th>
<th>moderately weak and insubstantial</th>
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**RATING SCALE 3 – EFFORT**  
*Do you think this taste took more or less effort than normal for you to eat and swallow?*

<table>
<thead>
<tr>
<th></th>
<th>Less effort</th>
<th>More effort</th>
</tr>
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<tbody>
<tr>
<td>Mint</td>
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**RATING SCALE 4 – TIME**  
*Do you think this taste took more or less time than normal for you to eat and swallow?*

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<tbody>
<tr>
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<tr>
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</table>

**RATING SCALE 5 – ACCEPTABILITY**  
*Considering all the scales above would you eat this?*

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
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<tr>
<td>Mint</td>
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### Room 2 Additives

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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Vodka</td>
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<tr>
<td>Pure Lemon Juice</td>
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Room 1 Patty Mixed/ Characteristics

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