Perceptual Mapping of Chemesthetics in Spanish and English Speakers

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Introduction

- Chemesthesis describes chemical stimulation of the touch system, and this encompasses many non-taste, non-smell sensations that are perceived in the mouth. These sensations (e.g. burning, cooling, tingling) have very high high commercial relevance.
- Over the past 30 years, American tastes have changed, as interest in and consumption of 'hot' spicy foods have increased. For example, salsa overtook ketchup in terms of sales in 1992.
- Over the same time period, demographics have shifted, with Hispanics and Latinos comprising the largest proportion of recent immigrants to the United States.
- With these changing demographics and tastes, and an increasingly diverse food supply, more research is needed on food percepts as well as the language used to describe those percepts across cultures.
- Concepts, and the words used to describe those concepts, are difficult to translate across languages for a variety of reasons:
  - Concepts may not exist in another language/culture
  - No direct translation (e.g. no direct translation from the English word "taste" to German, Italian, or Spanish (Zannoni 1996)
  - Greater exposure to concept leads to greater "sensory word richness" in some languages (e.g. 10 words in Eskimo language to define snow; Zannoni 1996)

Goals of the Project

- Compare the *perceptual maps* of chemesthetic agents across the two largest linguistic groups found in the United States: Latin American Spanish and North American English.
- Compare the *words* used to describe these perceptions across groups

Methods

Participants – 30 individuals were recruited from the Penn State campus and surrounding area. All conditions, stimuli, and instructions were constant across all participants. The protocol was approved by the Penn State University Institutional Review Board; informed consent was obtained and participants were compensated in cash. Exclusion criteria included pregnant or breastfeeding, smoker (last 30 days), known taste or smell problems, piercings of the lip, tongue, or cheeks, history of chronic pain, current use of prescription pain medication, or a history of chocking or difficulty swallowing. Participants were between 18 and 65 years. The Spanish speakers indicated they communicated in "mostly Spanish" or "both Spanish and English," and that they (or at least one parent) were originally from at least one Central or South American country, including: Mexico, El Salvador, Guatemala, Belize, Honduras, Nicaragua, Costa Rica, Panama, Columbia, Venezuela, Ecuador, Peru, Argentina, Bolivia, Chile, Paraguay, and Uruguay.

Stimuli – 9 chemesthetic agents and 2 tastants were used (allyl isothiocyanate (AITC), carvacrol, capsaicin, cinnamaldehyde, eucalyptol, eugenol, Hua Jiao (sanshool), menthol, zingerone, citric acid, and quinine. Stimuli were dissolved in ethanol (95%, USP, Koptec, King of Prussia, PA), or reverse osmosis (RO) water, as appropriate, to make stock solutions. Cotton swabs were dipped in stock solutions and dried for either 3h (EtOH) or 10h (RO H_2O).

Protocol – Participants rehydrated swabs in 10mL RO water (35C). They rolled the swab across their tongue 3 times, rubbed the swab against the roof of their mouth 3 times, breathed in through their mouth 3 times, and touched the tip of their tongue to the roof of their mouth 3 times. Participants sorted stimuli before rinsing with water (35C RO water). During a 3-min ISI, participants rinsed ad libitum (at least twice) until no sensation lingered. Any retasting was done treating the sample as a new sample. All stimuli and rinse water were expectorated. After all samples were tasted and groups were formed, participants supplied descriptors for their groups. Finally, participants filled out a language history questionnaire (adapted from Li et al 2006), the Food Involvement Scale (FIS; Bell and Marshall 2003), and Arnett's Inventory of Sensation Seeking (AISS; Arnett 1994).

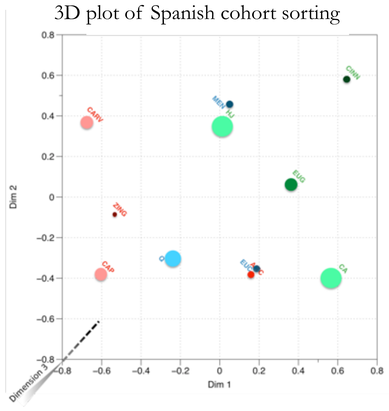
After completing the first session, participants were invited to complete a follow-up card sorting task online. They were asked to sort the 24 most commonly generated words by participants during the in-person session into groups. Data were analyzed by MDS and cluster analysis using the *smacof*, *coeffRV*, and *agnes* libraries in R.

Recruitment, sample preparation, and data collection for the Spanish-speaking cohort were conducted were by LMB. The results presented here also include an English-speaking cohort collected separately by NKB using an identical protocol. This work was supported by funds from the Pennsylvania State University and a National Institutes of Health grant DC10904 to JEH.

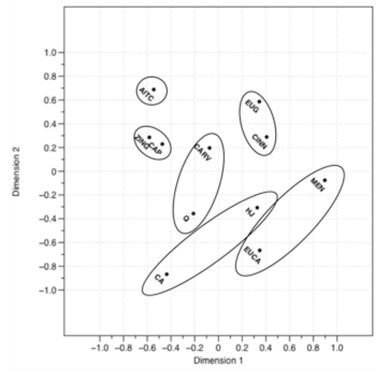
Results and Discussion

Panelist demographics. Roughly even men/women split in each cohort. No significant difference in age (mean age ~ 28 years old) or FIS score between English (N=51) and Spanish speakers (N=30). Spanish speakers had significantly higher overall AISS and Novelty Seeking subscale scores than English speakers.

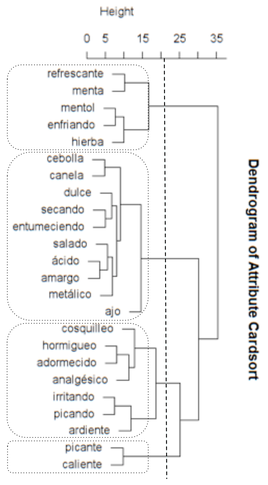
3D plot of Spanish cohort sorting



2D plot of English cohort sorting



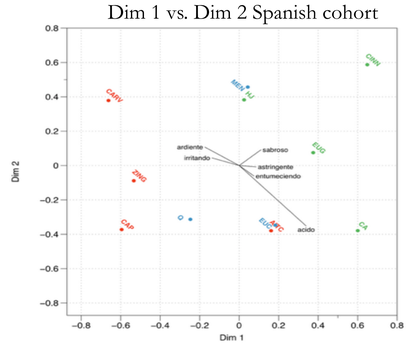
- English and Spanish speakers generated significantly different perceptual maps (NRV= 0.35, p = 0.14; NRV measures significance of similarity). A 3-dimensional solution was most appropriate for the Spanish speakers, while a 2-dimensional solution was most appropriate for the English speakers. (The 3D plot above left is a Natta projection plot, where the largest, lightest points are closest to the viewer along dimension 3, and the smaller, darker points are farthest from the viewer.)
- The Spanish speakers generated 3 clusters (indicated by blue, green, and red) while the English speakers generated 6 clusters.



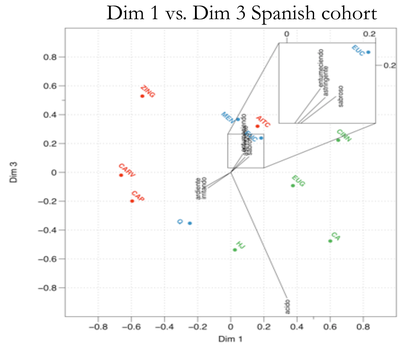
- The follow-up online sorting of the 24 most common attributes by the Spanish speakers showed 4 main word groups (left; the pruning distance is indicated by the dashed line).
- Groups consist of a "refreshing" group (top), a group describing specific foods and prototypical tastes (2nd), a group referring to various touch sensations (3rd), and a group referring specifically to hot and spicy (bottom).
- The third and fourth group, which both describe chemesthetic sensations are closely related on the dendrogram.

Results and Discussion

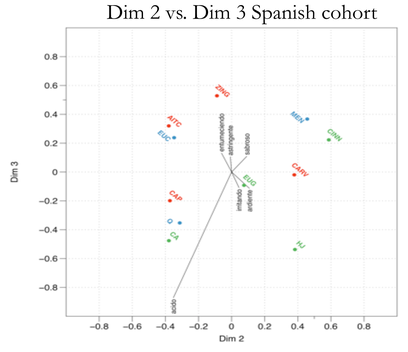
Dim 1 vs. Dim 2 Spanish cohort



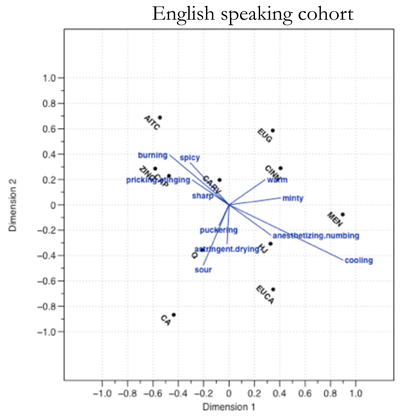
Dim 1 vs. Dim 3 Spanish cohort



Dim 2 vs. Dim 3 Spanish cohort



English speaking cohort



- While the Spanish speakers generated more than double the number of unique attributes compared to the English speakers, there was less agreement among the Spanish speakers on which attributes described which stimuli. Regression showed 6 significant attributes from the Spanish speakers, while 11 were significant for the English speakers.
- Both English and Spanish speakers generated a bipolar axis that represented pain or feeling.
  - English: drying – numbing
  - Spanish: burning – numbing
- The English cohort generated a second bipolar axis from burning to cooling, while the Spanish cohort generated a unipolar sour axis.
- There is considerable similarity in the plot regions associated with burning/ irritation (AITC, capsaicin, and zingerone).
- Substantial differences were noted for the placement and grouping of other stimuli:
  - Spanish speakers combined eugenol, cinnamaldehyde, hua jiao, and citric acid, while the English speakers split eugenol and cinnamaldehyde from hua jiao and citric acid.
  - Menthol did not associate with any specific descriptor in the Spanish speakers.

Conclusions and Future Work

- English speakers showed more finite discrimination between the stimuli and there was more agreement in the English speakers as to the sorting configurations and attribute assignment than in the Spanish speakers. This may be due to the fact that the Spanish speakers came from 9 different countries in Central and South America, which may have introduced regional variation in the words used to describe sensations, resulting in wider range of attributes generated. Future work using native Spanish speakers who have a more similar background in culture, food ways and language is needed to explore these influences, at the potential cost of generalizability beyond the group being tested.
- Spanish speakers showed significantly higher scores on the Novelty Seeking subscale and the total AISS. This suggests that the Spanish speakers may be more adventurous regarding food. Indeed, unlike many English-speaking participants, many Spanish-speaking participants noted they could identify hua jiao as a sensation common to Sichuan cuisine.
- We hypothesized the Spanish speakers would have more "sensory word richness", as these participants are more often exposed to highly spiced foods in their native cuisines. The results presented here suggest that the Spanish speakers do in fact have a richer language for chemesthetic stimuli. However, the results also indicate that Spanish speakers are more idiosyncratic with the use of these descriptors.