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The effects of acclimation to the United States and other demographic factors on responses to salt levels in foods: An examination utilizing face reader technology

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ABSTRACT

The aim of this study was to assess the role of extended time in the United States (as defined as a continuous period greater than two years; referred to hereafter as "US Acclimated"), as well as other demographic factors, on the level of net positive response of consumers to different salt levels in food samples. One hundred panelists were recruited, including 50 meeting our US acclimation criterion. Panelists assessed samples of potatoes with five different levels of salt concentrations, and the levels of their net positive responses were evaluated with FaceReader technology (Noldus). The data of our study showed a significant positive association between US Acclimated participants and the level of net positive response to samples with higher salt contents. This interaction remained statistically significant even when modeling the effects with consideration of race/ethnicity and gender. Another notable outcome was the unexpected significant interaction between gender and US acclimation in regards to evaluated positive response across all salt concentrations (US Acclimated females demonstrating substantially and significant higher levels of positive response than US Acclimated males). The association between living in the United States and showing more positive response to higher salt contents is consistent with many persistent characterizations of the eating habits in the United States, but it is not in fact well explained by the most recent data regarding the observed levels of average sodium consumption across worldwide geographical regions. The results of this study may be demonstrating evidence of underlying as-yet-unknown factors contributing to the responses of consumers to salt levels in foods. Further examination of these possible factors may well be warranted.

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1. Introduction

Due to its low cost and wide array of functional properties in foods, salt is one of the most widely used additives in the food industry (Khan & Abourashed, 2011). Salt works as an effective preservative and anti-microbial agent, and is also a highly effective flavor enhancer (Desmond, 2006). Therefore, efforts by food companies to increase shelf-life and safety of foods have historically contributed to increases in salt contents in foods, as have efforts to gain competitive advantages in the marketplace by improving desirability of products. As a consequence, the average total daily intake of sodium per adult in developed countries is now 4–5 g of

sodium, more than double the 2 g daily recommended by the World Health Organization (WHO) (World Health Organization, 2012). These high levels of salt intake are associated with extensive health concerns, including hypertension and an increased risk of chronic cardiovascular diseases (Albarracín et al., 2011). In 2010, 1.65 million annual global deaths were determined attributable to excessive salt intake, accounting for 9.5% of all deaths from cardiovascular causes (Mozaffarian et al., 2014).

Despite its frequently referenced reputation as a "Fast Food" culture, data suggests the problem of excessive salt intake is not specific to the United States (Albarracín et al., 2011; Murray, ; Elliot & Brown, 2006; Schlosser, 2012). In fact, recent studies suggest excessive salt intake is prevalent enough worldwide that it cannot be isolated to specific segments or categorizations of the world population (Elliot & Brown, 2006). A recent thorough meta-analysis of sodium intake as determined by urinary excretions found that

181 of 187 assessed countries had estimated mean levels of sodium intake in excess of the recommendations of the WHO, with the lowest values recorded in Kenya, and the highest in the country of Georgia (Mozaffarian et al., 2014). Another study documented sodium levels in urinary excretions within populations of 32 countries, and found the sodium levels within men in Chicago, United States (159 mmol/day) to be substantially lower than that of men in Beijing, China (223 mmol/day), and Hungary (232 mmol/day), among others (Elliot & Brown, 2006). Levels within men in Chicago were roughly comparable to those of men in South Wales, United Kingdom (179 mmol/day) and Iceland (158 mmol/day) (Mozaffarian et al., 2014). Still, the association between unhealthy salt levels in diets remains frequently culturally associated with the United States and other Western cultures (Elliot and Brown, 2006, Murray, ; Schlosser, 2012). Part of this association may be attributable to the prominence of food retailers and producers with origins in these areas that produce foods of high salt contents (Dunford et al., 2012).

In response to this health concern, 75 countries have salt reduction initiatives in place, which have been demonstrating modest incremental success towards alleviating the problem (Trieu et al., 2015). Remaining among the present barriers to greater success, however, is the fact that consumers generally continue to prefer food products with excessive salt levels, which presents great challenges for reduction in a competitive marketplace (Fellendorf, O'Sullivan, & Kerry, 2015). This preference for high salt content has been shown to be promoted by prior high levels of salt consumption, making the problem likely to compound over time within individuals (Bertino, Beauchamp, & Engelman, 1986). There is therefore possible promise in mitigating the preferences for detrimental levels of salt through further understanding of the role of acclimation, and this topic remains one that could benefit from further investigation (Bobowski, Rendahl, & Vickers, 2015). In addressing this point, this study investigates factors that may associate with consumer preference for high levels of salt in food, including a focus upon dietary acclimation to the foods of the United States.

Traditionally, measures of emotional responses to food products have been achieved by self-reported questionnaires and surveys (i.e. consumer likability assessments on hedonic scales). In contrast, this study utilizes FaceReader technology, due to its successful performance in our recent preliminary study evaluating this tool as an effective objective means to acquire such data (Khair, Blumberg, Feldman, & Wunderlich, 2015). FaceReader is a technological tool which combines visual recording of consumer panelists with a software algorithm that interprets emotional responses from visual cues on the faces of the panelists. Studies have found the emotional responses reported by FaceReader to be in 87% agreement with self-reported hedonic data (Danner, Sidorkina, Joechl, & Duerrschmid, 2014; He, Boesveldt, de Graaf, & de Wijk, 2016; Kostyra, Wasiak-Zys, & Rambuszek, 2016; Leitch, Duncan, O'Keefe, Rudd, & Gallager, 2015; Terzis, Moridis, & Economides, 2010), and it is speculated such objective analysis may in fact be of higher accuracy, due to biases which may occur in self-reporting. Specifically, in cross-cultural examinations, there are documented concerns of inconsistencies in emotional language interpretation, and also in interpretation of the gradation of how an emotion is to be interpreted and reported (Meiselman, 2015).

This study utilizes objective FaceReader algorithmic analysis to examine the possible association between acclimation to the United States and net positive responses to foods of different salt concentrations (using mashed potatoes as a model food system). Other demographic variables, such as gender and race/ethnicity, are also assessed in this study as possible contributing factors.

2. Methods

2.1. Panelist recruitment

Two cohorts were recruited: "US Acclimated" and "Recent Immigrant". Both cohorts were comprised entirely of subjects presently living in the United States. The designation of "US Acclimated" was defined as the subject having lived within the United States for a period of current and continuous time not less than two years. To be considered "Recent Immigrant", the subject must have lived in the USA for less than two years.

Panelists were recruited using emails, flyers, and social media. One hundred panelists were recruited, the majority of which were college students. The panelist population included 50 "US Acclimated" and 50 "Recent Immigrant". Additional demographic information was recorded for all panelists, and a summary of this information is shown in Table 1. This was done with the approval of the Montclair State University Institutional Review Board and all participants were over the age of 18 and provided their written consent before participation.

2.2. Sample preparation

Samples of mashed potato were prepared using dehydrated potato flakes purchased from Augason Farms (1911 south, 3850 West Salt Lake City, Utah 84104 USA). Dehydrated potato flakes and hot water were mixed at the ratio of 1:1 in the food mixer until a uniform texture formed. Five mashed potatoes samples with different sodium concentrations were prepared for each panelist. Each sample contained 15 g servings of mashed potatoes and was served at room temperature (72 °F). The sodium concentrations of the samples were attained by the addition of table salt (sodium chloride, with 40% Na), and were intended to be representative of general everyday usage cited in the literature (Lucas et al., 2011). The sodium concentrations of the mashed potatoes samples are shown in Table 2. All samples were then coded with numbers prior to being served to the panelists.

2.3. Sensory protocols and acquisition of FaceReader data

The analysis was conducted in the Nutrition and Food Science Laboratory at Montclair State University in Montclair, NJ. Only one panelist was seated in the laboratory at a time, to avoid possible communications among panelists. Panelists were given written and verbal instructions by the facilitator throughout the experiment. Panelists were informed they were to assess potato samples and that they would be recorded visually during assessment. Panelists

Table 1
Demographic characteristics of panelists.

Characteristic	Total (n = 100)
Length of Time in the US	
Less than two years ("Recent Immigrant")	50
More than two years ("US Acclimated")	50
Gender	
Female	46
Male	54
Race/Ethnicity	
White	34
Hispanic or Latino	3
Black or African American	12
Asian or Pacific Islander	3
Arab	48
Age, years. mean ± SD	23.8 ± 4.46