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Food texture assessment and preference based on Mouth Behavior

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ABSTRACT

The research presented validates the hypothesis that Mouth Behavior drives food texture choice and preferences. During qualitative research, when given a wide array of food products to choose from, there were clear texture differences between Mouth Behavior groups in the food items that were chosen as "love" or "not worth buying". The textures chosen as "loved" were those whose texture most matched their Mouth Behavior (could be easily eaten with their desired Mouth Behavior); while those foods that were rejected had textures that did not allow them to be easily eaten with their primary Mouth Behavior. These differences were then validated quantitatively, where food texture preference were shown to significantly differ by Mouth Behavior group, not only in overall texture, but also in hardness and eating time. Additionally, in previous qualitative research, study participants were found to perceive the texture of the same foods differently. Individuals tried to manipulate the product into a texture that could be eaten as desired, and therefore the texture of a given food was perceived differently by each group. This research also demonstrates that texture is not static, and that texture changes over the eating experience. The way the texture changes is of primary importance in determining food product acceptance.

1. Introduction

It is well known that texture is important to product liking and preferences. Texture can be a major reason for food rejection (Drewnowski, 1997) and one of the strongest drivers of food aversion (Scott & Downey, 2007).

In trying to understand food texture preferences, a preponderance of research has focused on describing and measuring textural attributes sensorially and then relating the sensory textural attributes to liking. Much of the research to understand the textural drivers of liking has utilized highly trained panels to describe texture and then statistically relating those textural characteristics to consumer liking (for example, candy (Kalviainine, Schlich, & Tuorila, 2000), cheese (Murray & Delahunty, 2000), poultry (Sow & Grongnet, 2010), and liquid dairy (Richardson-Harmon et al., 2000)).

In many cases, texture is analyzed in conjunction with other sensory attributes for flavor (taste and aroma). This is because flavor and texture are both drivers of food acceptance and the perception of one can change the perception of the other (Chen & Engelen, 2012; Pacikora et al., 2003).

While a significant amount of research has been done to measure texture, to group consumers based on their texture preferences (for example using cluster analysis) and to measure which textural attributes may drive liking, none of this research has focused on understanding what drives differences in textural rejection or preference. Without this understanding, food product developers rely on mathematical models to drive product formulation, without ever having a true person based/consumer understanding of why products are succeeding or failing.

Additionally, most texture research assumes that products have a static texture that can be agreed upon and described by trained panelists. Panelists are trained on a variety of attributes using standards (Munoz, 1986). The general assumption is that the properties of the food can be assessed by an overall rating of the attribute (crunchiness, cohesiveness, etc.) across the bite. In these methods, phase change such as melting are assessed, but not as a time factor (Civille & Seltsam, 2014; Lawless & Heymann, 2010). While techniques such as Time Intensity and Temporal Dominance of Sensation (TDS) do measure changes in texture over time, these techniques are not the norm, but are beginning to appear more often in research (Cheong et al., in press; Foster et al., 2011; Hutchings, Foster, Grigor, Bronlund, & Morgenstern, 2014; Kuesten, 2014).

Separately, there is a growing body of research on the oral processes during mastication. This research has highlighted some

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important findings, showing that chewing behavior varies by individual (Lassauzay et al., 2000; Po et al., 2011) and eating style (Engelen & van Doorn (in Engelen and de Wijk (2012))). Brown and Braxton (2000) also found that individuals use different mechanisms for the oral breakdown of food so that at any point, different groups of individuals would experience the samples differently. Therefore, they suggested that individual differences in the ability to manipulate and manage the product in the mouth may be a key driver of liking and personal preferences. However, the only link found in their research was a correlation between chewing force and preference.

Research by Jeltema, Beckley, and Vahalik (2014, 2015) has shown that consumers can be typed by the way they manipulate food in their mouths (Mouth Behavior (MB)) and that these groups of individuals show differences in food texture preferences. The existence of Mouth Behavior groups was first hypothesized by Jeltema and Beckley during qualitative observational research in which they noticed that individuals varied in how they wanted to use products in their mouths – for example, only a small subset of individuals wanted to hold a hard candy in their mouths until it dissolved – many crunched it with little or no time sucking it. Determining the differences between individuals and the existence of groups of individuals, the number of groups and developing an in-depth understanding of these groups adaptively evolved over a 10 year period using a series of qualitative research initiatives (over 350 h of listening, observing, and evolving the insights through the understanding). An ipsative approach, which "digs into the soul of the individual as a customer, ferrets out our needs and wants" was used to understand the individual (Moskowitz et al., 2012). Idiographs (pathways build upon what is expressly stated by an individual during a discussion anchored with some sort of stimuli) were developed by individual, and then the Mouth Behavior groups were built based on similarity of individuals expression of the experiences (Beckley & Lopetcharat, 2012). This is a ground up approach based on first thoroughly understanding the individual, and then determining how many different groupings emerge. This approach utilizes the two qualitative traditions – phenomenology and grounded theory (Creswell, 1998).

This exploratory qualitative research included observational research as well as in-depth, face-to-face inquiry into the differences in the ways individuals interacted with food and snacks. For example, individuals were asked to respond to a variety of statements aimed at understanding how they preferred to manipulate food in their mouths. They were asked to sort the statements (physically presented on cards with one statement per card) into three groups: (1) This is exactly like me; (2) This is somewhat like me; and (3) This is not like me. Some of the statements used are shown below:

- I like to suck on hard candy until it fully dissolves
- I usually break up hard candy quickly and swallow it
- I prefer hard crunchy cookies to soft chewy cookies
- I prefer soft creamy candies to hard candies

Based on more of these qualitative listening and observation studies conducted over several years (more than 350 h of observation and listening), it was hypothesized that there were four major mouth behavior groups. The categorization of these four groups are: (1) Crunchers, (2) Chewers, (3) Suckers, and (4) Smooshers. These groups fell into two major modes of mouth actions. Mode one, represented by Crunchers and Chewers, were those who liked to use their teeth to break down foods. Crunchers were more forceful in their bite and preferred foods that broke up (fractured) on biting. Chewers liked foods that could be chewed longer (the length of time varied-there seemed to be "short" Chewers and "long" Chewers) and did not fracture on biting. Mode two, represented by Suckers and Smooshers, preferred to manipulate food between the tongue and roof of the mouth. They differed primarily in the hardness of preferred foods. Suckers liked harder foods (like hard candies and items that they could hold in their mouths) that could be sucked on for a long time. Smooshers preferred soft foods, such as creamy candies (like the wrapped candy called Cow Tales^{R} (Goetze Candy Co,) or puddings that did not require much mouth activity but would spread throughout the mouth and could be held in the mouth for a long time. The key behavioral differences between Mouth Behavior groups, such as principle needs, observed behavior, and mouth action, determined from these qualitative discussions can be found in Supplementary materials (Table 1 of supplementary materials).

While this research led to the ability to type an individual through qualitative discussion, it was not until the creation by Jeltema of the JBMB® Mouth Behavior Typing Tool (Fig. 1), that quantitative validation was possible. This tool is a visual algorithm that uses an elegantly simple pictorial pattern recognition method, allowing an individual to easily type themselves, by picking the group of pictures and description that is "most like them". The descriptions, for example, "I like foods that I can crunch" are followed by foods with textures that are easy to "crunch". The other descriptions are "I like foods that I can chew". I like foods that I can suck on for a long time and I often suck on them until they dissolve" and "I like foods that I can smoosh, I even smoosh foods that I could chew".

This tool, while simple to execute, was the result of an extensive amount of iterative research and was conceived after many failed attempts using more complicated, yet traditional survey tools (Jeltema, Beckley, & Vahalik, 2014, 2015). The pictures were carefully chosen to represent those products that would best differentiate between groups. Variations on a theme were used when possible to differentiate the groupings (e.g., variations on ice cream). While an individual will probably "like" some foods in each group, on the whole, they will find one group of foods, more "like them". The use of multiple products also avoids pitfalls with specific flavors or specific foods. The textures of the foods were chosen to be those that are most easily "manipulated" by each Mouth Behavior group in the desired way. This is critical, as individuals are unaware of how they manipulate food in their mouths – thus, food textures are used to aid in that association.

The final validation of the tool was done by conducting a quantitative survey (N = 500), where individuals were typed by the JBMB® typing tool and then asked a custom word based survey (67 questions) which included a variety of behavioral questions (e.g., eat ice cream out of freezer vs. let it soften) and textural preferences (chewy cookies vs. crunchy cookies).

Responses were first compared across groups using chi-square analysis to determine whether the different mouth behavior groups were answering the questions differently followed by a discriminant analysis, using the JBMB® typing tool mouth behavior classification as the Y variable and using the questions from the word survey as the X variables. This analysis demonstrated that there were indeed different groups of individuals that could be separated using the data ($p < 0.0001$). The development of the Mouth Behavior hypothesis, through the validation of the tool are described in detail in Jeltema et al. (2014, 2015).

As hypothesized by Brown and Braxton (2000), the early observational work did demonstrate that the Mouth Behavior groups show food preference differences and that there were food textures that fit "best" with each mouth behavior (the basis of the JBMB® typing tool and shown in the discriminant analysis used to validate that tool). The aim of this research was to understand more fully the drivers of these food preference differences in terms of the textures that these groups would most prefer vs. those that they might reject, and that differences in textures that drove preference

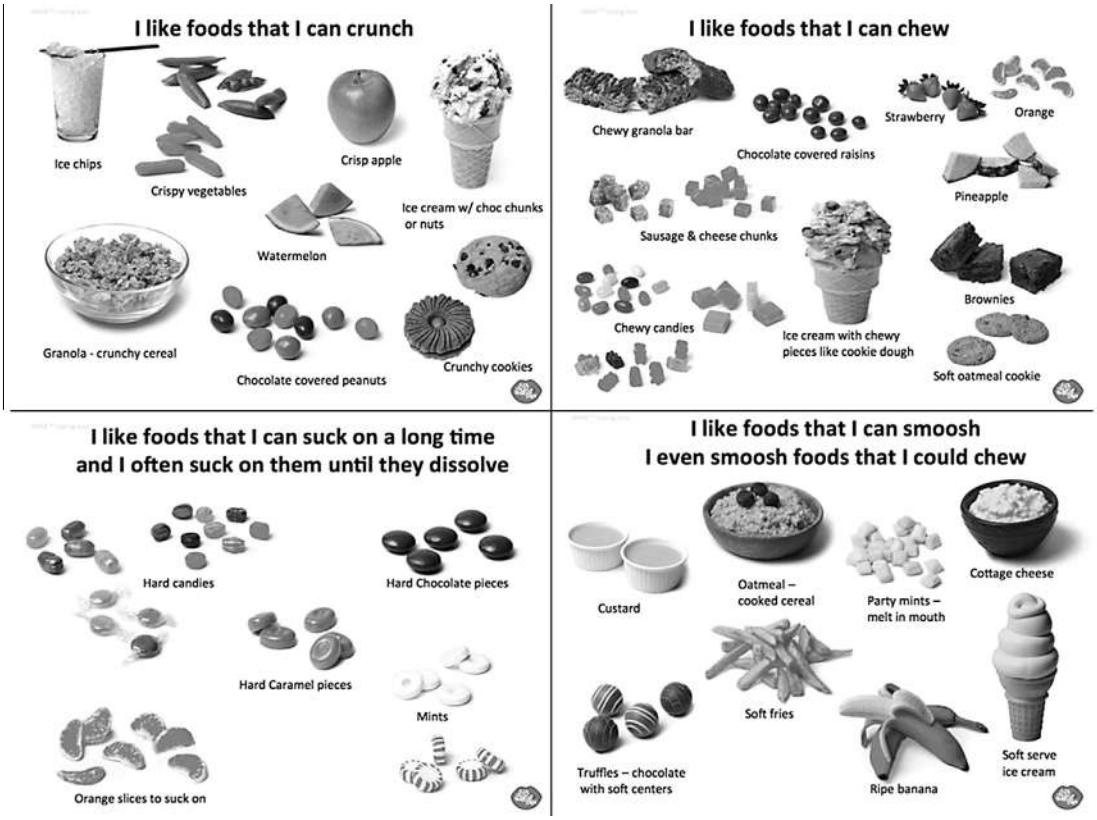

Fig. 1. Graphic Mouth Behavior typing tool (JBMB® typing tool). All rights reserved.

could be shown in a way that would make the relationship between product preference, product texture and Mouth Behavior clearer. This led to the first hypothesis.

Hypothesis 1. The heterogeneity that exists among individuals as to food product preference and rejection can be explained by Mouth Behavior and can be shown to be based on key textural parameters. (Qualitative Research, Case Study I).

Landscape mapping (a modification of Projective mapping, Risvik et al., 1994) was used to elucidate the important aspects of texture that drove product preferences.

These differences would provide further supporting evidence that the Mouth Behavior groups, identified by the JBMB® typing tool, show key differences in textural preferences and would offer a simple method for Designers, Developers and Marketers to understand their products through the lens of Mouth Behavior. While there is a general belief that quantitative data is an essential validation tool, it is generally accepted that qualitative work should be done prior to quantitative research (Kuhn, 2014), in order to ask the right questions in the right way. As articulated by VanBeselaere (2004), "Since standard survey questionnaires do not provide respondents sufficient opportunity to explain in detail how they feel about different issues nor do they provide researchers the breadth of information necessary to fully understand how respondents perceive different questions, interviews were determined to be the most appropriate means of uncovering information". For product research, qualitative methods provide a much richer understanding of product attributes and the drivers of consumer liking/disliking and emotional connections. For both of these reasons, qualitative research was conducted first. Quantitative research was undertaken to further "validate" the textural drivers of preference differences across mouth behavior. This led to the second hypothesis.

Hypothesis 2. Quantitative research would support the findings of the qualitative research. Significant differences between texture preferences could be shown and would show the same patterns as the qualitative mapping. (Quantitative Research, Case Study I).

During the research protocol phase, it was observed that foods thought to be crunchy by one member of the research team were perceived differently by other members of the team. This was an unexpected finding. It provided a critical realization: individuals with different mouth behaviors were not perceiving the texture of foods similarly and could not agree on the texture of their samples. Since the research team was composed of people with different Mouth Behaviors (validated through the use of the typing tool (Fig. 1)), it was theorized that Mouth Behavior difference could be the reason. This hypothesis was supported by Brown and Braxton (2000) which suggested that there were differences between chewing efficiency groups in how sensory characteristics were "understood or perceived". This observation led to a third area of inquiry – understanding whether the Mouth Behavior groups would perceive texture of the same food differently, and if so, how?

Hypothesis 3. Individuals, in many cases, will perceive the texture of the same food differently because they are bringing their Mouth Behavior preference to the food being eaten. (Qualitative Research, Case Study II).

It is important to note here that this hypothesis does not imply that different foods, e.g., carrots and yogurt, do not have different obvious textural differences. This hypothesis, instead suggests that any given food e.g., cooked carrots may be perceived differently in texture by individuals in different Mouth Behavior groups.

The work of Brown and Braxton (2000) grouped individuals by eating efficiency, measured by number of chews, chew time, and chew rate. Qualitative differences in Mouth Behavior groups (Sup-

plementary material Table 1) also suggested that chew time differs by group. Differences in chew time was therefore, also explored.

2. Methods

In order to explore *Hypothesis 1*, in depth qualitative workshops were used, based on the belief that a difficult topic such as Mouth Behavior, which involves an unconscious behavior, requires the time and attention to fully understand a person's behavior and reasons for that behavior. As stated by VanBeselaere (2004), "In-depth interviews offer a means of collecting data that cannot be easily uncovered through traditional survey formats. The interviews, undertaken as part of this study, allowed respondents the opportunity to explain what they were thinking".

For the *Hypothesis 2,* quantitative research followed the qualitative research. For the research it was important to demonstrate that these findings were robust enough to be shown quantitatively, with a less sensitive tool such as survey data, due to the common practice of data quantitation believed to be necessary for validation.

For the *Hypothesis 3*, In-depth discussion allowed in qualitative research was the best approach to understand texture perception. This work was exploratory in nature and in the "understanding" phase, most suited to in-depth qualitative inquiry.

2.1. Case Study I – perceived texture of products that are "loved" versus "not worth buying"

2.1.1. Qualitative research methodology (Hypothesis 1)

2.1.1.1. Samples. The products in this case study included a wide variety of items (48) with different textures, such as types of bars, candy, chocolate, cookies, chips, etc. Snack foods were used for this research for several reasons: (1) There were a very wide range of products that consumers would be familiar with, (2) a wide range of single textures could be represented, (3) all were packaged foods and were therefore consistent in their texture properties, (4) snacks represent foods that are voluntarily chosen and therefore will be more likely chosen based purely on product preferences of the individual.

2.1.1.2. Consumer participants. Qualitative workshops were conducted with individuals of the different Mouth Behavior groups. Selection of the individuals for the research was based on their typing on Mouth Behavior using the JBMB® (Jeltema/Beckley Mouth Behavior) typing tool (Jeltema et al., 2014, 2015) shown in Fig. 1. Participants selected were a mix of gender and ages (between 15 and 64) with no known food allergies. No disqualifications were made on the basis of dental condition (screening has been added to later research). This qualitative research included thirty individuals: 12 Chewers, 11 Crunchers, 4 Smooshers and 3 Suckers. The goal of the qualitative research was to develop an understanding of the drivers of textural acceptance and critical differences between Mouth Behavior groups, which could later be measured quantitatively. This is a robust sample of individuals for qualitative purposes (Silver & Thompson, 1991). They found that 8 individuals identified over 80% of the needs, which was only slightly lower than 8 focus groups of 10 individuals each. Beckley and Jeltema (unpublished), in their own work over the last 17 years, have also found this to be true. While Suckers and Smooshers are low in number (they are more difficult to recruit due to their smaller population distribution within the US), their number was felt to be sufficient to develop working hypotheses around these groups when compared to the other groups and to be able to compare the results with the quantitative research.

2.1.1.3. Consumer workshop flow. Participants were shown a large array of foods (foods placed on tables) that they might choose for snacks and were asked to choose three that they "loved" and three that were "not worth buying" based on the texture of the products. This scale is a variation on the love/hate scale (Moskowitz et al., 2005). "Love" was used, to allow individuals to pick those products that stood out from all others. "Love was used rather than "would buy/always buy" because it is believed that many "loved" products are not purchased because they represent foods that are difficult for some people to resist consuming in large quantity; and since they contain large amounts of calories, are avoided. "Not worth buying" was used because it represented products that were not necessarily "hated", but would have properties that made them not worth the effort or money to buy. Conversation around choices and reasons for those choices followed. If during the conversation it became clear that choices were not based on texture, but rather flavor, participants were asked to choose another product, based solely on texture.

After product choice and the discussion around product textural differences that drove acceptance/rejection, individuals were asked to map the products on a 2 dimensional texture map (texture landscape, Fig. 2). This approach is a variation on projective mapping (Risvik), in that products are mapped based on similarly, but the variables used to map the product similarities/differences are broadly discussed and then agreed upon by the mapping participants prior to mapping (and these axes may change if the participants realize that their initial consensus is either too broad or too restrictive to allow the mapping needed to describe the experience). The axes were consumer elicited during prior research (Jeltema and Beckley, unpublished) and represent a "best" solution by the participants for mapping the textures. Discussions occurred with the participants regarding the rationale for this "consumer" view, allowing the research team to understand the mapping from these experienced users and obtain agreement on the axes. The horizontal x axis was degree of hardness, while the vertical y axis indicated whether the products were perceived as smooshy, chewy, crunchy, or too hard to crunch or chew. No definition of these terms was provided, since the research was interested in consumer language and perception. In-depth conversation was conducted with a subset of individuals (18) to deepen the understanding around the types of products they were attracted to or tended to avoid.

To support *Hypothesis 1*, it was expected that regions of texture would be grouped by "love" and "not worth buying" but differ by Mouth Behavior group.

2.1.2. Quantitative research methodology (Hypothesis 2)

2.1.2.1. Consumer participants. To quantitatively validate this qualitative research, an online survey was conducted among 500 males and females, ages 15–65. A pre-screener was used to facilitate balance across age, gender and region according to the US Census. The data was then cleaned to remove those individuals who were found to be "careless responders" e.g., gave all the same ratings on a scale to all products. After cleaning there were 464 respondents.

The quantitative approach was designed to parallel the methodology used as in the qualitative research. Individuals were first typed using the JBMB® typing tool (209 Crunchers, 184 Chewers, 55 Smooshers, 16 Suckers). The number of Suckers was lower than expected (expected ~40) based on previous quantitative sampling of the U.S. population (Jeltema et al., 2014). Therefore the sample size was less than desired. Future research in this area may want to put quotas (augmentation) on these groups as sampling variation is present when using a market sample. Although the sample size was smaller than desired, these data were included as they are

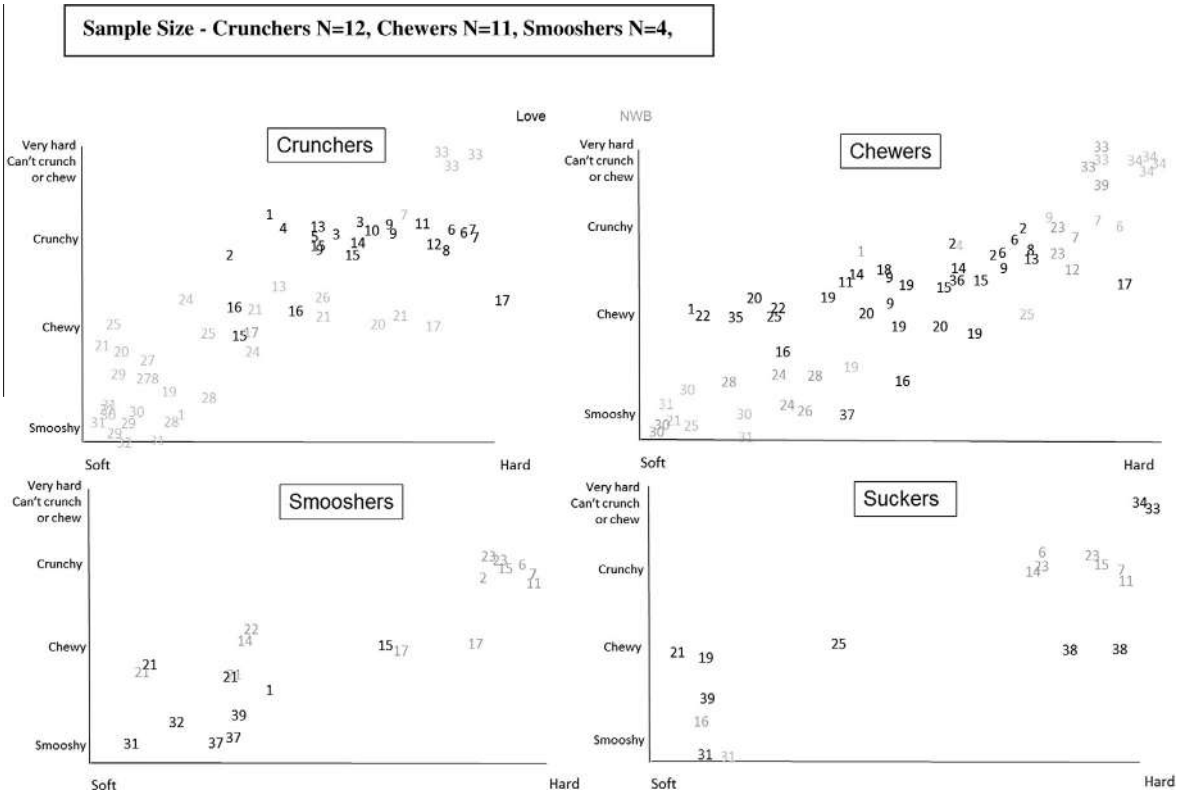

Fig. 2. Qualitative results of food preferences of Mouth Behavior groups, showing differences in texture areas "loved" (dark gray) or "rejected" (light gray), in support of *Hypothesis 1*.

consistent (from qualitative to quantitative) and provide important data that can be built upon in future research.

2.1.2.2. Research flow. Individuals were shown a list of 60 products, and asked to pick 3 products that they "love" and 3 products that were "not worth buying." They were directed to focus on and respond based on the texture of the products. The list of products included a wide variety of items with different textures, such as types of food bars, chocolate and non-chocolate candy, cookies, chips, cereals, snacks, etc. This was an expanded list of the 48 used in the qualitative research (sample of these are shown in Supplementary material Table 2). The expansion was done to begin to gather information beyond decisions based on snack food, into areas like fruits and vegetables. This expanded list added robustness to the research by going beyond manufactured to more naturally produced foods. As in the qualitative research, participants were asked to pick the texture of the products (smooshy, chewy, crunchy, too hard to chew or crunch) and then rate the products on hardness (very soft [1] to very hard [10]). From previous research on differences between MB groups (Supplementary material Table 1), it was believed that the length of the time to eat a bite (short [1] to long [7]) would differ and could be measured. Based on previous qualitative data, it was believed that texture preferences would differ both on hardness and the length of eating time.

Intensity scales were used rather than landscape mapping, because it was believed that online consumers would not be able to do that task on a computer screen without the explanations and guidance that is provided in a qualitative session, along with the desire to create survey anchored responses data.

2.1.2.3. Analysis. Differences between texture preferences across the MB groups was analyzed using a chi-square analysis (Table 1) and the differences between the intensity scales were analyzed using ANOVA (Tables 2 and 3). As one goal of the research was to show that quantitative data could be used to mirror qualitative data, the results on texture and hardness were mapped in a similar way to the qualitative maps. In order to map the data, the data was first sorted across individuals into products that were "loved" and "not worth buying (NWB)". Scale ratings on hardness were condensed into 3 groups – soft (ratings from 1 to 4), medium (ratings from 5 to 7) and hard (ratings from 8 to 10). Then tallies (counts) were made of the number of products that fell into each area of the map, e.g., loved and smooshy/soft, loved and smooshy/medium, loved and smooshy/hard, loved and chewy/soft, etc.). Then, for each area, the tallies for products that were loved were compared to the tallies of the number of products that were "not worth buying". For example, for Smooshers, in the smooshy/soft area, 50 products might have been "loved" and 25 products might have been "not worth buying". A flow of this analysis is shown in Supplemental information (Supplementary materials Fig. 1). A chi-square analysis was used to determine for each area of the map, which showed significant differences between the numbers of products "loved" vs. "not worth buying". These results were then shown by using bubble charts, where the size of the bubbles represented the relative size of that tally (Fig. 3).

Tallies were also made of the number of individuals who chose each product as "loved" or "not worth buying". The number of individuals choosing each product was then compared to the expected value if choice was random. Tables 4 and 5 show those products that were chosen significantly more often than expected.

Hypothesis 2 would be supported if there were significant differences due to texture of products that were "loved" vs "NWB" by MB group (both in categorical texture and in hardness ratings) and that these differences could be mapped similarly to the qualitative texture landscape maps.

Table 1
Texture preference differences by each Mouth Behavior Group – chi square analysis on counts.[a]

	Overall P < 0.0001								
Texture counts:					Pairwise comparisons:				
Mouth behavior:	Smooshy	Chewy	Crunchy	Too hard		Chew	Crunch	Smoosh	Suck
Love it									
Chewer	88	272	198	6	Chew	1	P < 0.0001	P < 0.0001	P < 0.0001
Cruncher	108	222	354	9	Crunch	P < 0.0001	1	P < 0.0001	P < 0.0001
Smoosher	69	78	44	7	Smoosh	P < 0.0001	P < 0.0001	1	0.537923
Sucker	15	19	10	4	Suck	P < 0.0001	P < 0.0001	0.537923	1
NWB									
Chewer	148	165	148	103	Chew	1	0.019295	0.024591	0.096492
Cruncher	229	211	148	105	Crunch	0.019295	1	0.001529	0.595402
Smoosher	39	78	41	40	Smoosh	0.024591	0.001529	1	0.031786
Sucker	19	16	7	6	Suck	0.096492	0.595402	0.031786	1

[a] Counts = number of times a product with a given texture was chosen by each Mouth Behavior group.

Table 2
Average hardness ratings by each Mouth Behavior Group by products "loved" versus "not worth buying (NWB)".[a]

Products "Loved"		Products "NWB"	
Sucker	6.46 A	Sucker	6.23 AB
Cruncher	5.56 A	Smoosher	6.09 A
Chewer	4.84 B	Chewer	5.42 B
Smoosher	4.6 B	Cruncher	5.17 B

	Cruncher	Chewer	Smoosher	Sucker
Products "Loved"	5.56A	4.84A	4.60A	6.46
Products "NWB	5.17B	5.42B	6.09B	6.23

[a] Significantly different at p < 0.05, based on intensity scales from 1 (low hardness) to 7 (high hardness).

Table 3
Average eating time for products "loved" versus "not worth buying (NWB)" each by Mouth Behavior.[a]

Products that were "Loved"			Products that were "NWB"		
Sucker	6.25	A	Suck	6.19	A
Cruncher	4.61	B	Smoosh	5.85	A
Smoosher	4.22	B C	Crunch	5.28	A B
Chewer	4.02	C	Chew	5.11	B

	Cruncher	Chewer	Smoosher	Sucker
Products "Loved"	4.61A	4.02A	4.22A	6.25
Products "NWB"	5.28B	5.18B	5.85B	6.19

[a] Significantly different at p < 0.05, based on intensity scales for how long it takes to eat a bite 1 (short time) to 7 (long time).

2.2. Case Study II – comparison of product textures by mouth behavior (Hypothesis 3)

2.2.1. Samples

The products used were Walkers® Shortbread (a rectangular shortbread cookie), Mentos® (hard shell with soft chewable inside piece candy), Twix® (shortbread cookie with a layer of soft caramel and coated with milk chocolate), and Cheetos® Puffs (extruded cheese snack). These products were specifically chosen because (1) it was hypothesized that the products would show differences in liking by Mouth Behavior groups, (2) that the different MB groups could eat many of these products using their preferred Mouth Behavior, and (3) three of the four (Walkers®, Mentos®, and Twix®) are more or less globally available and would assist in more global research in the future.

2.2.2. Consumer participants

Qualitative workshops were conducted with consumers derived from the different Mouth Behavior groups. Participant selection for the research was based on their typing on Mouth Behavior using the JBMB® typing tool (Jeltema et al., 2014, 2015) shown in Fig. 1. Participants were a mix of gender and ages (15–64), with no known food allergies. No disqualifications were made on the basis of dental condition (screening has been added to later research). To test the hypothesis that individuals will perceive the texture of foods differently, qualitative workshops were conducted with 40 individuals: 19 Chewers, 12 Crunchers, 7 Smooshers and 2 Suckers.

2.2.3. Research flow

Individuals were asked to take a bite of 4 different products and map the products on a 2 dimensional texture map. No instructions were provided on how large the bite should be, due to interest in the individuals normal behavior). Individuals could try several bites of any item, if needed, for assessment. The x axis was degree of hardness, and the y axis indicated whether the products were perceived as smooshy, chewy, crunchy, or too hard to crunch or chew. This mirrored the mapping done in Case Study 1.They were then asked to rate the products for liking using "love it", "so-so" and "not worth buying". Again, a subgroup of individuals (13) were asked to discuss the texture of each food, what drove their liking, and what they were looking for in the texture of products.

3. Results

3.1. Case Study I

3.1.1. Qualitative results

The heterogeneity that exists among individuals as to product preference and rejection can be explained by Mouth Behavior and can be shown to be based on key textural parameters. Results by Mouth Behavior group are shown in Fig. 2, which identifies the areas of perceived texture that were "loved" vs. "not worth buying" by each group. Products associated with Fig. 2 are shown in Supplementary material (Table 2). It is clear by these maps, that each group had a different area for products that were liked and disliked

Crunchers (Fig. 2) primarily chose products that were perceived, by them, as "medium hard to very hard and crunchy" as products that they "loved". Products that were rejected fell in the "smooshy" or "too hard to crunch or chew" range. Chewy products were more often rejected than loved by Crunchers. It is important to note that just because a product is viewed as a texture that is not optimal, does not mean that it will be rejected. As long as a product can be managed in the mouth using the preferred Mouth Behavior, it will not be rejected, and other factors such as flavor can move it into the "love" category.

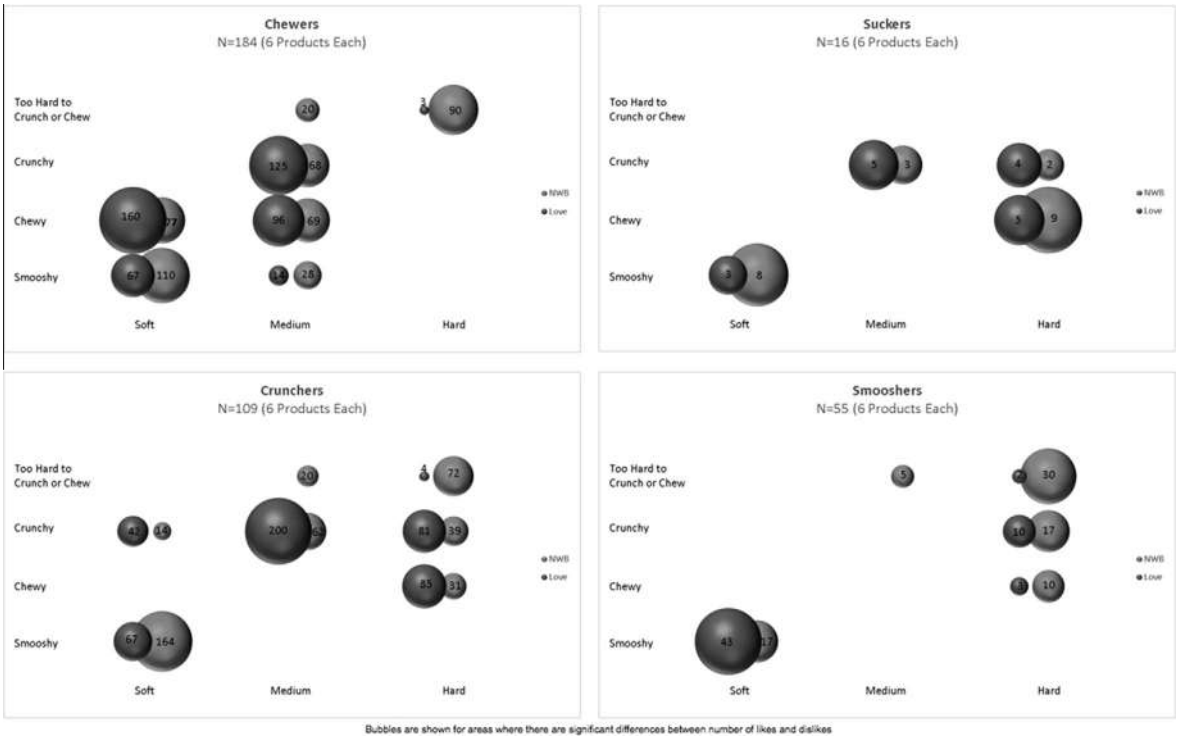

Fig. 3. Quantitative results of food preferences of Mouth Behavior groups, showing differences in texture areas "loved" (dark gray) or "rejected" (light gray), in support of *Hypothesis 2*.

Table 4
Comparison of products that were "loved" by each Mouth Behavior group.[abc]

Crunchers	Chewers	Smooshers	Suckers
Hard Granola Bar – ex. Honey/Oat Nature Valley	Chewy Granola Bar ex. Quaker Chewy	Truffles – Lindor	Hard mints(.05)
Peanut M&MS	Peanut M&MS	Soft granola bar w/fruit center – ex. Strawberry Nutrigrain	Soft granola bar w/fruit center – ex. Strawberry Nutrigrain
Milk Chocolate Bar w/almonds – ex. Hershey	Soft Oatmeal Cookies	Soft Oatmeal Cookies	Chewy Granola Bar ex. Quaker Chewy(.05)
Classic Lays Potato Chips	M&MS (regular)	Classic Lays Potato Chips	Hershey's Bar – regular size
Beef Jerky	Reese's Cup – traditional cup size	Blended Yogurt – ex. Yoplait	Chocolate Covered Pretzels
Crunchy Cheetos	Starbursts – wrapped squares	Oatmeal	Gummy bears – traditional ones
			Mentos
			Chocolate Covered Raisins
			Twix – regular flavor, regular size
			Snickers

[a] Products on this list were chosen significantly higher than chance, were higher than the mean across all groups, and had higher number of likes than dislikes.
[b] Products are significantly different from chance at $p < 0.05$ for Crunchers, Chewers, and Smooshers. Suckers are significantly different at $p < 0.10$, if not otherwise indicated.
[c] Naming of products in the table follows the naming convention from the survey they were evaluated in for this research.

Table 5
Comparison of products that were "not worth buying" by each Mouth Behavior group.[abc]

Crunchers	Chewers	Smooshers	Suckers
Kind Bar – classic nut version (may have fruit)	Shredded Mini-Wheats	Heath Bar	Ginger Snaps by Nabisco
Soft granola bar w/fruit center – ex, Strawberry Nutrigrain	Mentos	Starbursts – wrapped squares	Hard Granola Bar – ex. Honey/Oat Nature Valley(.05)
Chewy Granola Bar ex. Quaker Chewy	Gummy bears – traditional ones	Chewy Granola Bar ex. Quaker Chewy	Classic Kettle chips ex. Cape Cod
Gummy bears – traditional ones	Hard candy assortment	Gummy bears – traditional ones	Pretzel Rods
	Hard mints	Hard candy assortment	Pudding
		Hard mints	Beef Jerky/Slim Jims, Pepperoni Sticks(.05)
		Marshmallows	Custard
			Oatmeal/Cream of Wheat(.05)
			Grape Nuts/Flakes ex. Special K or Corn Flakes

[a] Products on this list were chosen significantly higher than chance, were higher than the mean across all groups, and had higher number of dislikes than likes.
[b] Products are significantly different from chance at $p < 0.05$ for Crunchers, Chewers, and Smooshers. Suckers are significantly different at $p < 0.10$, if not otherwise indicated.
[c] Naming of products in the Table follows the naming convention from the survey they were evaluated in for this research.

Chewers (Fig. 2) primarily loved products that they would categorize as "chewy" in texture. These products ranged from "very soft and chewy" to "very hard and chewy". Some individuals chose products that moved into the "crunchy" area. In discussion, these chewers indicated that acceptable products in the crunchy area began as crunchy, but became chewy over the eating experience. Rejected products most often were considered "smooshy"," too hard to chew or crunch", or "very hard and crunchy". When hard crunchy products were rejected it was often because they were perceived as being very dry (a specific product description not made by Crunchers).

Smooshers (Fig. 2) loved products that they perceived as "smooshy" and tended to reject products that they viewed as "chewy" or "hard and crunchy". When a chewy product was loved, it tended to be one that could be *eaten in a way* that allowed the product to be smooshed (such as Twix®).

Only 3 individuals were Suckers (only a small proportion of the US population fall in the Sucker group). The Sucker data is shown in order to form hypotheses around this group when compared to the other groups and to be able to compare the results with the quantitative research. Compared to the other Mouth Behavior groups, Suckers (Fig. 2) had more than one texture area for preferred products. While they chose products in the "too hard to chew or crunch" area, they also chose products that were chewy. The only texture area rejected, fell in "hard and crunchy". Upon reflection, these individuals indicated that they enjoyed products that could be alternatively sucked and chewed. They liked to suck the flavor off or out of the product before chewing it. The overriding criteria was that the product had to be comfortable to hold in the mouth and have flavor (type and amount) that could be enjoyed by sucking on the product.

3.1.2. Quantitative research results

Hypothesis 2, Quantitative research would support the findings of the qualitative research. Significant differences between texture preferences could be shown and would show the same patterns as the qualitative mapping.

The results of the quantitative statistical chi square analysis are shown in Table 1. From the counts of products "loved" or "not worth buying" these results show significant differences based on Mouth Behavior group by texture preferences. These data will be used later in the discussion to compare the maps created qualitatively and quantitatively.

Results from hardness perception and preferences are shown in Table 2. The ANOVA showed significant differences for Mouth Behavior group ($P < 0.0001$), products "loved" versus products "not worth buying" ($p < 0.01$) and the interaction between MB group and liking ($p < 0.0001$). From the data, it can be seen that Suckers and Crunchers rated products that were "loved" higher in hardness than did Smooshers or Chewers, who picked products that were softer. Conversely, the products that were "not worth buying" were rated softer by Crunchers, but were hard for Smooshers and Chewers. Suckers did not differentiate liking based on hardness. From the qualitative data, they are more concerned with comfort in the mouth and flavor extraction.

For time to eat, results (Table 3) showed that Suckers felt that products took the longest to eat (overall rating of 6.2), followed by Smooshers (5.04), Crunchers (4.94) and Chewers (4.57). Observational data has shown that Smooshers and Suckers do indeed spend more time eating any particular food; however, our qualitative data suggests that Crunchers take the shortest amount of time. The discrepancy may be due to observations that Chewers tend to fall into 2 groups, short chewers and long chewers. This group may have been comprised of more short chewers. As with the hardness data, Suckers did not differentiate liking based on time to eat, but spent a long time using all products. Products that were chosen as "not worth buying" were rated as taking longer to eat by both Crunchers, Chewers, and Smooshers.

A key goal of this survey was to show that quantitative data could be used to mirror the results obtained qualitatively. The qualitative data is powerful in that it pictorially shows the differences in liking and perception of Mouth Behavior groups based on texture perception, and a key textural attribute that was used by consumers to differentiate products, i.e., hardness.

The results comparing the four Mouth Behavior groups on maps generated to mirror the qualitative data are shown in Fig. 3. As with all survey data, there was more variability ("noise") in the data than evident in the qualitative research. This is not only due to the larger number of individuals, and therefore, larger evident variation, but was also related to decreased lack of interest/motivation and attention by individuals taking survey tests (VanBeselaere, 2004). The prevalence of careless responses has been estimated to be anywhere from 3.5 to 50% depending on the criteria used to assess responses. This same research found that inappropriate responses increase from beginning to the end of surveys (Meade & Craig, 2011). There was certainly more data that did not appear to be realistic, for example, individuals indicating that products such as oatmeal or pudding were "too hard to chew or crunch". However, even considering these limitations, the data in Fig. 3 demonstrated the same trends as observed in the qualitative data. The data are shown as graphics that compare the response "sizes" of bubbles within each Mouth Behavior group. Shown are only those areas where the "love" were significantly different from the "not worth buying" and indicates he direction of the difference. Significance level for Crunchers, Chewers and Smooshers are shown at $p < 0.05$. Due to the small sample size for Suckers, these data should be considered more directional in nature, therefore bubbles are shown for areas where the "loves" and "not worth buying" differ by a factor of 2.

Crunchers indicated a preference (significantly more likes than dislikes) for products that were "medium hard" to "hard and crunchy". They showed significantly more dislikes to likes for products that were either "soft and smooshy" or "very hard and too hard to chew or crunch". These results mirror those shown in Fig. 2.

Products that Chewers "loved" fell more often in the texture area of soft to medium on the hardness scale and chewy, but extended into the medium crunchy texture area. This is similar to the qualitative research (Fig. 2), however, based on discussion with consumers in the qualitative research, it was hypothesized that these products probably became chewy over the eating experience. Also, as in the qualitative research, areas of texture that were more disliked, fell in the areas of "soft and smooshy", "hard and crunchy", or "hard and too hard to chew or crunch".

The texture area of "loved" products for Smooshers (significantly more liked than disliked products) fell in the texture areas "soft and smooshy". This area extended somewhat into the "soft and chewy", but the differences were not significant and therefore are not shown. Disliked products were very hard – most often "too hard to chew or crunch" or "hard and crunchy".

While the quantitative data was also small for the number of suckers (16), the data supported the qualitative data. Liked products could vary vastly in texture, but tended to be products that were not too soft (semi-solid). As hypothesized in the qualitative research, liked products appeared to be easy to extract the flavor upon sucking and not hard and dry (Table 4).

Comparisons of products that were listed as "loved" or "not worth buying" can be seen in Tables 4 and 5. The products in Table 4 represent those that were chosen as "loved" significantly more than chance, had numbers higher than the mean across all groups, and had more individuals who chose them as "loved" as opposed to "not worth buying". Products in Table 5 had similar cri-

teria (chosen as "not worth buying" significantly more often than chance), were higher than the mean and had higher numbers for "not worth buying" as opposed to "loved". Products in Table 4 can be easily related to the textural areas that each group found appealing. For example, the Crunchers listed products that are "hard and crunchy" or have a crisp or crunch factor (such as raw vegetables or fruits such as apples). The chewers listed products that they considered to be chewy. Smooshers listed either very soft, semi-solid foods or those that could become very soft in the mouth. Similarly, the products listed in Table 5 are associated with texture that were most often chosen as "not worth buying" (very chewy for Crunchers, very soft or hard for Chewers, very hard or chewy for Smooshers, and difficult to suck on to remove flavor for Suckers).

3.2. Case Study II

Hypothesis 3, comparison of product textures by Mouth Behavior. Individuals will perceive the texture of foods differently because they are bringing their Mouth Behavior preference to the food being eaten.

The texture landscape maps for the four products evaluated in qualitative research are shown in Figs. 4–7, one map for each product. Each map shows the assessments of texture by each Mouth Behavior group (most common regions shown by ellipses which indicate the area of product placement). Liking is represented by the color of each ellipse (green = love, yellow = so-so, red = NWB). Along with the maps, comments from a subset of participants are included to provide context. Due to the limited number of individuals who were interviewed, these comments should be taken more as hypotheses than fact and need to be explored further. Some products were evaluated similarly on texture by all groups (e.g., Mentos®), while other products were placed in very different texture locations by the Mouth Behavior groups (e.g., Walkers®).

In Fig. 4, Mentos® was viewed as "chewy" by all Mouth Behavior groups. However, the hardness of the chew varied by group, as did liking. The Suckers in this research, liked the Mentos® as they felt it could be enjoyed for an extended time. Because they were sucking on the product before chewing, it became soft over time and was therefore viewed as a somewhat soft chew. On the other extreme, Smooshers disliked the Mentos® because it remained hard (could not be smooshed) and required a long time to eat. The Smooshers indicated that they would probably throw it out before finishing. This group rated the Mentos® as very hard. Chewers gave varied responses on liking (most between "love" and "so-so"), depending on how long a chew they enjoyed. Crunchers, in general, rated the Mentos® as "so-so", as they found it difficult to bite through completely. With all of these maps, there were outliers. For example, one of the Crunchers who placed Mentos® as being "very soft and smooshy". When questioned, this participant could only say that she "didn't like it", so that is where the inquiry had to terminate. This observation demonstrates the difficulty that some people have separating texture from liking, a difficulty that is compounded with techniques such as survey research, where there is no in depth thought or query.

The Walkers® shortbread (Fig. 5) is an example of a product that was described very differently on texture and liking by the different Mouth Behavior groups. Most Crunchers thought that the shortbread was a "medium hard crunchy", and liked the texture (ranged from "love" (7) to "so-so" (5). Chewers were not consistent in their texture placement, and their placement drove liking. One group of Chewers thought the shortbread was "crunchy" – and those consumers tended to rate the product as "so-so" (5 out of 8 consumers). Another group; however, thought the shortbread was "chewy". Those consumers tended to "love it" (8 out of 9 consumers). These consumers spoke of liking a fullness or creaminess in the mouth that allowed them to "chew" the product. Smooshers placed the shortbread as being "very soft and smooshy". By holding the product in their mouths, they were able to add saliva and turn the product into a texture that could be smooshed (and many liked). The Suckers did not agree on placement, but also disliked the shortbread. They described it as not comfortable to suck on.

Cheetos® Puffs (Fig. 6) is another product that was viewed differently on texture by the Mouth Behavior groups, and also showed less consistency within a group. Crunchers thought the puffs were crunchy and all liked them – but differed somewhat on how hard a crunch they felt it had. Most thought the puffs was a "very soft crunch", but a few placed it as a "harder crunch". Most chewers agreed that the product was a "soft crunch". The majority of Chewers liked the puffs, but the liking for this group depended on whether they felt that product became full enough in the mouth to chew as it softened. Some did not feel there was enough material to chew. A subset of Chewers felt that the puffs was almost smooshy. These individuals tended to not like the puffs ("so-so" or "not worth buying"). A majority of Smooshers felt that puffs was smooshy, while several felt it was chewy. Most of the Smooshers liked the puffs as it softened. Again, the two suckers did not agree on texture, but both liked the puffs, as it could be sucked on to remove flavor.

Twix® (Fig. 7) represented a product with multiple, very different textures, related to its product design of a cookie, chocolate,

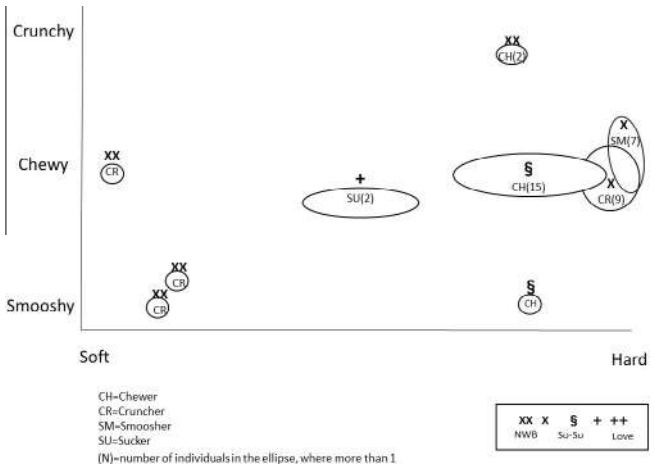

Fig. 4. Mentos® texture landscape map showing differences in texture perception and liking by each Mouth Behavior group, in support of *Hypothesis 3.*

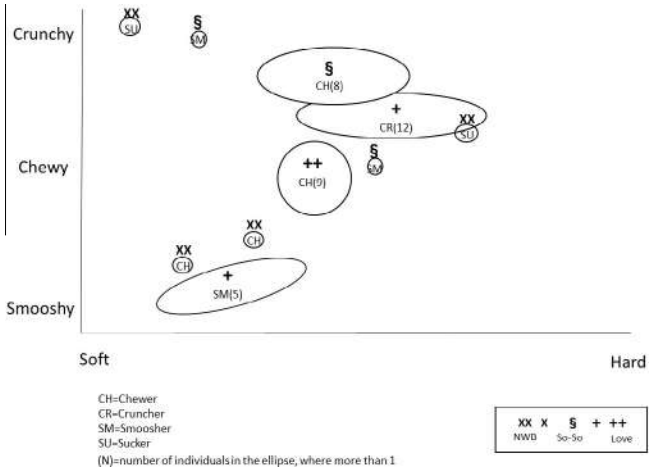

Fig. 5. Walkers® Shortbread texture landscape map showing differences in texture perception and liking by each Mouth Behavior group, in support of *Hypothesis 3.*

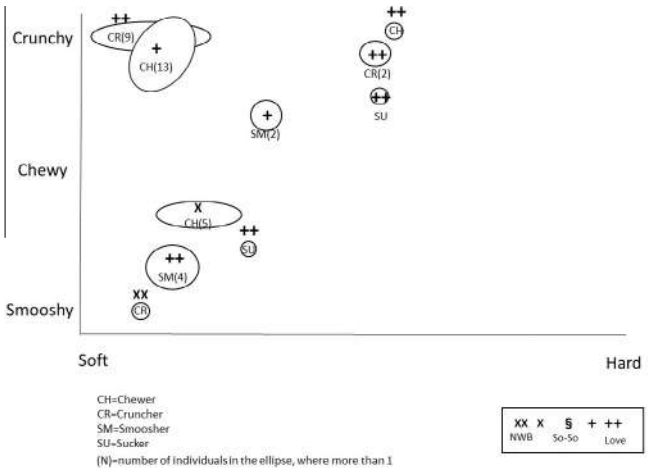

Fig. 6. Cheetos® Puffs texture landscape map showing differences in texture perception and liking by each Mouth Behavior group, in support of *Hypothesis 3.*

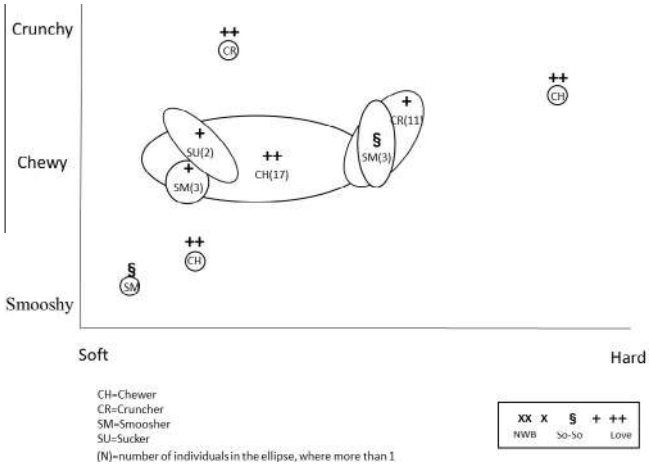

Fig. 7. Twix® texture landscape map showing differences in texture perception and liking by each Mouth Behavior group, in support of *Hypothesis 3.*

and caramel. All of the groups agreed that the product was chewy "overall", but all mentioned a crunchy component. The Twix® was generally "loved" by all Chewers. Crunchers, rated it as "love" to "so-so", depending on how much crunch they felt it had and how well they could bite through the chewy components. Smooshers differed in their liking depending on how they ate the Twix. Some reported separating the components, so that they could get rid of the cookie then smoosh the rest. They talked about "Chipmunking" the product (holding in the side of the mouth). The Suckers enjoyed the Twix® since it could be alternatively sucked and chewed.

4. Discussion

Previous research in Mouth Behavior informed the thinking that product acceptance and rejection are driven by Mouth Behavior (Jeltema et al., 2014, 2015). The current research further validated these initial findings and supported *Hypothesis 1*: *The heterogeneity that exists among individuals as to product preference and rejection can be explained by Mouth Behavior and can be shown to be based on key textural parameter.* From the qualitative landscape maps there were clear differences shown in the textural areas preferred or rejected by the different Mouth Behavior groups. Products that most easily allowed a person to eat the food with their preferred Mouth Behavior were most liked and preferentially chosen. Foods that were rejected were difficult or impossible to eat using the preferred Mouth Behavior. Although Mouth Behavior drove general product acceptance, individual differences within a group were found in the discussion that demonstrated rejection of foods based on sensitivity to certain textural factors, such as stickiness in teeth, dryness in the mouth, or graininess. The degree to which these factors drive rejection and the percentages of individuals in each group that have these sensitivities needs further research.

The different groups also had different rejection criteria. Chewers were most likely to mention "dryness" of products to be a reason for rejection. This often was mentioned in association with hard, dry products (like crunchy food bars or cookies). The degree of rejection depended on an individual's sensitivity to dryness. Some Chewers would reject products that were too "sticky;" that stuck too completely to the teeth.

Crunchers rarely mentioned or noticed dryness of foods. Rejection of hard, dry products was most often due to grittiness or pastiness of the food (it did not clear the mouth quickly). Again, sensitivity to this varied by the individual. It would be interesting, in future research, to understand the role of salivary flow in texture perception.

Smooshers did not want to have to work hard to eat a food. Working hard meant having to "chew" or use their teeth to eat. Therefore, hard products that could not be made easily soft with saliva were rejected. The same was true of very chewy products or products that were smooshy, but grainy. They tended to be very slow eaters and all of the participants talked about situations as children where they had eating difficulties because of time taken to eat their food.

The Suckers who were interviewed did not mind using teeth to chew, but preferred products that could be sucked on or alternatively sucked and chewed (similar to other Suckers previously interviewed). While both the Suckers and Smooshers preferred mouth action that does not involve teeth, they have very different preferences. This was clearly demonstrated by the Mentos®. Both left the Mentos® until last to eat, the Smooshers because they were dreading eating it; the Suckers because they wanted to have time to enjoy it.

It was initially hypothesized that the Sucker would be most limited in satisfying food choice, as few foods can be "only" sucked on. However, the Sucker has adopted a strategy of alternatively chewing and sucking foods. There was actually a long list (Table 5) of foods that the Sucker found to be satisfying. These were foods that could be sucked on but were not uncomfortable to hold in the mouth. This did not include many hard rough grainy products or very soft semi-solid products. However, of ultimate importance was the ability to enjoy the flavor by sucking on the product and comfort in the mouth as it dissolved.

The qualitative research formed the basis for further quantitation, by defining the questions and attributes that would be used for quantification. This quantification was believed to be essential, as the validity of purely qualitative data is often called in question. The results of the quantitative study supported *Hypothesis 2: Quantitative research would support the findings of the qualitative research. Significant differences between texture preferences could be shown and would show the same patterns as the qualitative mapping.* In addition, this research was able to show that, while standard statistical analysis could be used to show statistical differences, the data could also be mapped in ways that allowed direct comparison to the qualitative mapping exercise. This pictorial demonstrated how quantitative data could be used to show the relationships that existed between the Mouth Behavior group and texture preferences.

Brown and Braxton (2000) found that individuals could be grouped by chewing efficiency and that chewing rate correlated

with food preference. When the Mouth Behavior groups were first being studied, a hypothesis was generated about there being a time dimension that was important to understanding these groups. Observation of the individuals in the qualitative research, suggested that Crunchers were the fastest eaters, followed by Chewers, with Suckers and Smooshers being much slower. These differences in eating time by the different Mouth Behavior groups have also been found by M. Morgenstern for certain foods (personal communication). The results of this quantitative study did show differences in preference for products with different eating times. In general, the average rating of eating time for Chewers was the shortest, and Suckers the longest. In the future, it may be possible to relate their "chewing efficiency" groups to Mouth Behavior groups

However, there may also be a time dimension within each group. Qualitative Mouth Behavior listening suggested that there is a time factor at play within some of the groups. That is, individuals within a MB group varied in the amount of time he/she wanted to spend with the food in their mouth. So, there were Chewers who wanted a short chew (individuals who typically prefer soft products) and those who preferred a long chew. There may be similar differences within the Smoosher or Sucker groups. With Crunchers, the variation may be more around the hardness of the crunch rather than the length of time it is crunchy. These differences require more investigation to confirm. Once confirmed, these findings can be used to further fine tune and enhance the methodology.

Brown and Braxton (2000) in their work on oral processing, found that individuals grouped by chewing efficiency differed in their perception of texture. They hypothesized that liking would be driven by how easily a product could be managed in the mouth. This current work supports their hypothesis as well as *Hypothesis 3: Individuals, in many cases, will perceive the texture of the same food differently because they are bringing their Mouth Behavior preference to the food being eaten.* The qualitative work conducted in Case Study 2, showed that there were differences in texture perception across individuals, and many of these differences related to Mouth Behavior group.

The differences in texture perception by the different groups suggests that any given food will not be perceived to have the same texture by all individuals, and will vary by Mouth Behavior group. This in turn calls into question whether evaluation of the texture of foods by a trained panel will be representative of consumer texture perception.

Because individuals from the different Mouth Behavior groups ate foods differently, they also perceived the texture of products differently. People reported trying to manipulate the product in such a way that it could be eaten with the preferred Mouth Behavior. So, a Smoosher might try to turn a product into something smooshy (sometimes by letting it soak in saliva), while a Cruncher would bite through the product rapidly and clear it out of the mouth quickly. A Chewer could want the product to turn into a "soft ball" or enough of a mass that it can be "chewed". Since a Sucker was not chewing many products initially, initial textures were often perceived as either "hard" or "soft".

The findings that food texture assessment differs by Mouth Behavior group is also supported by research by Morgenstern (2014). Researchers at the New Zealand Plant and Food Research Center used these same food models in their work to understand the differences in oral processing by the Mouth Behavior groups. They accompanied their oral processing work with TDS, a sensory technique that looks at perception of attributes over time. Their research also showed some differences in texture perception, as the TDS maps differed by Mouth Behavior group (different patterns of response).

While this research demonstrates that texture perception differs by Mouth Behavior group, these findings are based on a small number of individuals. Thus, results should not be considered to be the "absolute" placement, but more a demonstration that texture perception will differ by the way the products are eaten by each Mouth Behavior group. More research is needed to fully understand how textural change is associated with acceptance/rejection by group, and how individuals make decisions on overall texture, when the perception is constantly changing through the eating experience. There are some indications that the overall texture may be assessed based on the texture that is perceived to be of longest duration during eating rather than the beginning texture (e.g., if it starts hard but becomes soft and chewy and stays soft and chewy, then it's texture might be rated as soft and chewy). However, this may vary by individual.

As indicated in the results section, the number of Suckers used were lower than desired, and therefore these data could be further validated.

In addition, much needs to be understood about the role of physiological differences and their relationship to Mouth Behavior, to include: salivary flow, mouth size, dental bite, dental condition (braces, etc.) and dental health.

5. Conclusion

Understanding Mouth Behavior and its implications on product perception is critical to new product development. First, it demonstrates that textural preference is driven by Mouth Behavior group and therefore needs to be taken into account when developing products and measuring product acceptance. Additionally, traditional methods of assessing texture assume that texture attributes will be perceived similarly by all individuals who recognize the descriptor and can be measured by a trained panel, which is very prescriptive in how to manipulate and measure the food in the mouth. However, if individuals do not perceive texture similarly, then it is unclear whether these measurements currently predict consumer acceptance. Trained panels need to evaluate the effect that Mouth Behavior may be having on the way individuals are assessing texture and find ways to account/manage these differences. This research demonstrates that textural perception is fluid, and is affected by an individual's Mouth Behavior group and how the person manipulates the product over time.

Note on the JBMB® typing tool

Upon request, this tool may be provided from It! Ventures LLC (no fee) to academics who wish to conduct research into the implications of Mouth Behavior or to expand knowledge in this area and are committed to publishing of papers for the benefit of the research community. For all commercial researchers, the tool may be accessed through the website – http://mouthbehavior.com for a small fee per use.

Authors contributions

Beckley performed all qualitative interviews and participated in the collection of the qualitative data; Jeltema also collected qualitative data and developed, in conjunction with Beckley and Vahalik the quantitative survey tool. The quantitative survey data collection was overseen by the Vahalik and primary data analysis was conducted by Jeltema. Quantitative data collection was conducted in October of 2014, across the United States.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.foodqual.2016.04.010.

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