

Relative Satiety Value of Candy and Gum: Potential Therapies for Childhood Obesity

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Abstract

Compliance with diets is notoriously difficult. Surrendering to hunger with excess consumption is one factor contributing to childhood obesity. In adults, foods have been ranked based on satiety value. The same has not been performed for preferred foods and gum amongst children. A group of ninety children was subdivided to assess satiety through four different paradigms. Using one slice of white bread as a standard reference, a childhood satiety index was established for eight different types of candy and twelve different flavors of sugar-free gum. Candies were provided in isocaloric 100 kcal portions and gums were five kcal or less. Before consumption, and fifteen and thirty minutes afterwards, satiety values were assessed using a visual analog scale. Amongst the candies, Starbursts and Gummi Bears demonstrated the greatest satiety value, one-third more than white bread and almost double that of Tootsie Rolls. The sugar-free gums all revealed satiety values statistically equivalent to that of one slice of white bread or a one-hundred calorie slice of apple pie. Mandibulation of sugar-free gums may thus induce the same degree of satiety but with less than one-twentieth the numbers of calories. Use of hedonically positive candy and gum to induce satiety may have utility in repression of hunger and thus management of obesity.

Introduction

Obesity is endemic in American society [1]. Two out of three adults are either overweight or obese, provoking a cascade of chronic diseases ranging from diabetes to osteoarthritis [2,3]. Similarly, children have not been spared such an affliction. In the last 30 years among US children 6-11 years old, obesity prevalence has quadrupled [4,5]. Thirty-two percent are beyond normal weight [6]. Myriad factors have been postulated as contributors for this condition, primarily focusing upon reduced calorie expenditure coupled with excess consumption [7]. One of the mechanisms for regulation of such consumption is hunger, and its opposite, satiety, or the sense of fullness [8]. Hunger for food is the sensation of a desire or need to eat. Satiety is the sense of fullness or lack of desire to eat. Approaches that influence these may be useful in helping to reduce food intake.

A variety of factors have been postulated to impact satiety of both external and internal origin. External factors in food include bulk and volume, degree of flavoring, visual presentation, and relative fat, protein, and sugar content [9]. Internal mechanisms include the psychological, hormonal, physical, and chemosensory spheres. In the psychological realm, anywhere from the number of people with whom one eats, the duration of the meal, whether the television is playing during the meal, or even the belief that the food is of greater nutritional value, all affect the satiety level [10-13]. Hormones, including ghrelin, and leptin similarly can affect satiety [14]. Ingestion of food physically expands the stomach, causing stretch receptors to fire, signaling a sense of fullness [15]. This effect of volume of food inducing satiety has been labeled, allesthesia [16]. The chemosensory system, through smell and taste, regulates feelings of hunger through the process of sensory specific satiety [17]. All of these work together in regulating perception of fullness. Thus, satiety is not solely based on the number of calories consumed, but rather, on more complex internal and external factors.

Regardless of the underlying physiological mechanisms, assessment of degree of satiety produced through consumption of different foods has been proposed. In that study, isocaloric foods were categorized based on degree of satiety compared to a standard of white bread in 13 adults in Australia [18].

Use of commercially available chewing gum may also act to induce satiety. Chewing alone, without ingestion, has been suggested as a pathway for induction of satiety, possibly through jaw movement provoking release of serotonin, which indirectly acts to suppress appetite [19]. Experiments in adults have generally demonstrated mastication of chewing gum reduces hunger, and subsequent consumption. Mastication of unflavored gum decreased self-reported hunger ratings [20]. Consistent with these findings, food consumption after ten minutes of gum chewing was also demonstrated to be reduced [21]. Likewise, chewing sweetened and artificially sweetened gum for 30-45 minutes over a three-hour period decreased both hunger for sweets and sweet snack consumption [22,23].

Contradictory results have also been reported. Chewing artificially sweetened gum compared to no gum chewing was shown to actually increase hunger [20]. In another study, fifty adults chewing a 3 gram serving of Wrigley's Juicy Fruit Gum for twenty minutes had no effect on visual analogue scale (VAS) measurement of hunger rating [24]. Thus, the impact of chewing gum on satiety remains a question.

The relative satiety values on children for different flavors of chewing gum or brands of gum have never been assessed. In addition to gum flavors and brands, no similar satiety classification has been established in foods preferred and commonly consumed by children. Furthermore, no one has ever assessed the relative satiety value of food and gum sharing similar sensory properties (beyond sweet or salty).

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Experiment 1: The Relative Satiety Value of Candy Bars in American Children

The objective of this study was to determine if the satiety index which Holt had delineated using culturally relevant foods in Australian adults, would also apply to American children using hedonically preferred confectionaries [18].

Methods

Using satiety index of Holt as a model [18], eight different types of candy were chosen for examination. These were selected based on authors' hedonic preferences, availability at the local drug store chain, and ease of distribution in isocaloric packaging.

All candies were segregated for disposition in approximately isocaloric amounts of 95 ± 5 (See Table 1).

White bread (Wonder Bread, Small), two slices, with a total of 95 calories was also chosen for a baseline value, as per Holt's study [18].

Study subjects were recruited using a convenience sampling technique from seventh grade classes in a Chicago suburb. Selection criteria of volunteers was based on absence of allergy to nuts, no restriction with regard to eating of candy, and signed parental and child consent. All subjects were age 12 or 13. Forty-two percent [10] were boys and 58% [14] were girls. None experienced negative hedonics toward the foods tested. No one ate anything for one hour prior to testing, or anything other than test material during the testing session. Subjects were provided a different candy bar each day in a randomized order to avoid any influence of effect of order on presentation. Subjects, on a VAS, rated their degree of hunger from extremely hungry to full. (Figure 1). Integer values from one to seven were provided for each self-assessment hunger/satiety level, one being extremely hungry, and seven being full.

This was completed immediately prior to, immediately after, and 15 and 30 minutes after eating, as signaled by the principal investigator. Subjects were required to complete consumption of candy bar within two minutes of initiation. Forms were filled out independently and without sharing of information. Data was collected, collated, and statistically analyzed similar to that of the methods of Holt [18]. In that study, prolonged degree of satiety and amount consumed in snacks and at the next meal correlated with self-rating of satiety at 15 and 30 minutes. Degree of satiety was calculated by determining the area under the curve, the AUC (Figure 2).

The satiety index was calculated by determining the 15 and 30 minute post-prandial satiety level, adjusting for the initial level of hunger (i.e., if initially full, even consumption of more food cannot have an even greater effect on fullness, whereas if initially extremely hungry, a smaller amount of food may have a greater effect).

This was accomplished through the following calculation,

$$\frac{\text{Average AUC} - (2 \times \text{average pre - prandial satiety level})}{2 \times \text{subject size}} \times 100$$

This data was normalized (by multiplying by 1.15) to set white bread satiety index value equal to Holt's standard 100% [18].

Results

With white bread as a reference of 100%, 100 kcal of different

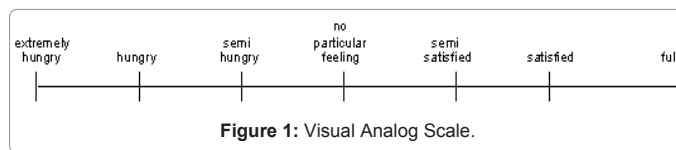


Figure 1: Visual Analog Scale.

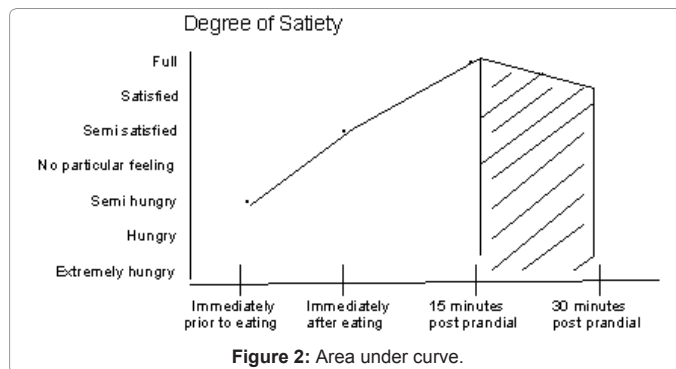


Figure 2: Area under curve.

No. of Candy Bar	Calories/Package	Packages	Total Calories
Peanut M&M's	90	1	90
Tootsie Roll Midgets	15.6	6	93.6
Twix	50	2	100
M&M's	90	1	90
Smarties	25	4	100
Star Bursts	20	5	100
Hershey's Kisses	20	5	100
Gummy Bears	90	1	90

Table 1: Calories of Candies.

Item	Subject Size (N)	Satiety Index
Tootsie Roll	24	79.06
M&M's	20	81.02
Hershey's Kisses	22	83.64
Smarties	24	88.64
Twix	21	95.83
Bread	23	100.00
M&M Peanut	23	124.58
Gummy Bears	24	132.25
Starburst	23	135.00

Table 2: Satiety Index of Candies.

candies demonstrated substantial differences in their satiating capacities, despite isoenergetic servings (Table 2).

Starbursts and Gummy Bears were approximately a third more satiating than white bread. Starbursts were 40% more satiating than Tootsie Rolls.

This study extends Holt's satiety index in regards to candy bars [18]. In that study, she found the average satiety index score for snacks and confectionary was 100; with Mars Bars being 70 and jelly beans 118. Those results were very close to what our findings were with similar candies: Twix 95.8, and Starbursts, 135. Furthermore, this was confirmed in a subject size twice that of Holt's [18]. These findings further extend the concept of satiety index from Australian adults to American children and refine it in reference to specific American confectionaries.

Experiment 2: The Relative Satiety Value of Chewing Gum in American Children

This work examines if commercially available chewing gum falls under the spectrum of the satiety index when applied to children. A standardized control, 110 calorie white bread, was then used to compare satiety value of these chewing gums.

Methods

Using the same satiety assessment protocol as in experiment one, 11 different types of gum were chosen for examination. These were selected based on authors' hedonic preferences.

All gums tested were ≤ 5 calories per piece. White bread (Texas Toast, Butternut), one slice, with a total of 110 calories was chosen for a baseline value, as per Holt's and Hirsch's studies [18,25].

Selection criteria of volunteers were based on no restriction with regard to chewing gum, signed parental and child consent forms and were recruited as per experiment one protocol. One-half were of each gender. None experienced negative hedonics toward the gums tested. Satiety index was accomplished as per experiment 1.

This data was normalized (by multiplying by 1.28) to set white bread satiety index value equal to Holt's standard 100% [18]. Statistical significance was determined using the small sample student *t* test for the difference between two means, with a confidence level of 95% [26,27].

Thus, the satiety of a slice of white bread served as the standardized control value, the independent variable was the type of gum, and the dependent variable was the satiety value of each type of gum.

Results

With white bread set as a reference of 100%, the satiety index level of the gums tested ranked at different degrees of satiety (Table 3, Figure 3).

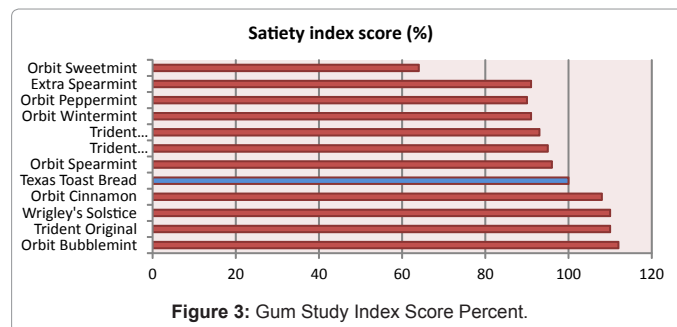
While Orbit Bubblemint was almost twice as satiating as Orbit Sweetmint, no statistically significant difference was seen with any gum compared to white bread ($t \leq 2.042$ at 3 degrees of freedom, $p > 0.05$). Hence, all gums tested delivered approximately the same satiety index as white bread, however with less than 1/20th the calories.

Experiment 3: The Satiety Value of Sugar Free Orbit Bubblemint Chewing Gum

The goal of this study was to determine, with a larger sample size, the satiety value of Sugar-free Orbit Bubblemint Chewing Gum as

Gum	Subject size	Satiety index	t Value
Orbit Bubblemint	19	112%	0.601
Trident Original	18	110%	0.218
Wrigley's Solstice	18	110%	0.228
Orbit Cinnamon	19	108%	0.172
Texas Toast White Bread	16	100%	
Orbit Spearmint	18	96%	-0.109
Trident Watermelon Twist	17	95%	-0.143
Trident Strawberry Twist	20	93%	-0.167
Orbit Wintermint	19	91%	-0.182
Orbit Peppermint	20	90%	-0.297
Extra Spearmint	20	81%	-0.555
Orbit Sweetmint	19	64%	-0.639

Table 3: Gum Satiety Values.



compared to white bread. It was hypothesized that a stick of sugarless chewing gum had a satiety value approximately equivalent to that of white bread, the normal standard control for food satiety studies [18,25,28].

Methods

With the same protocol of experiment 2, Sugar-free Orbit Bubblemint Chewing Gum with less than 5 calories per stick was chosen for examination. Study subjects were recruited using a convenience sampling technique from a middle and high school in a Chicago suburb. All subjects ranged from 12 to 17. Twelve were boys and ten were girls. None experienced negative hedonics towards the gum tested.

Satiety index was assessed as per experiment 2. This data was normalized (by multiplying by 2.08) to set white bread satiety index value equal to Holt's standard 100% [18]. Statistical significance was determined using the sign Test [26,27].

Thus, the satiety of a slice of white bread served as the standardized control value, the independent variable was the Sugar-free Orbit Bubblemint Chewing Gum, and the dependent variable was the satiety value of the gum.

Results

With white bread set as a reference of 100%, the satiety levels of the Sugar-free Orbit Bubblemint Chewing Gum were as per Table 4 and Table 5.

Average satiety index for white bread equals 0.48. Setting the white bread satiety index to equal 1.00.

$$0.48 \times 100\%, \text{ therefore } x = 2.08 \text{ (correction factor).}$$

Corrected satiety index of Sugar-free Orbit Bubblemint Chewing Gum:

$$0.61 \times 2.08 = 1.27 \times 100 = 127\%$$

While Sugar-free Orbit Bubblemint Chewing Gum was 27% more satiating, no statistically significant difference was seen compared to white bread. Using the sign Test, the two-sided *p* value equals 100%. Thus, the satiety index for both was not statistically significantly different. The null hypothesis was accepted: the satiety index of these two was approximately equivalent.

Experiment 4: The Relative Satiety of Apple Pie Compared to Apple Pie Flavored Gum.

The goal of this study is to determine the satiety value of Wrigley's Extra Dessert Delight Apple Pie Sugar-Free Gum as compared to a 100 calorie slice of apple pie.

Sugar Free Orbit Bubblemint Chewing Gum Satiety Level Based on Visual Analog Scale categorized 1-7 as per Illustration 1				
Subject	Initial	15mins	30mins	AUC (average of satiety level at 15 & 30 minutes)
1	3	2	2	2
2	4	3	2	2.5
3	3	4	2	3
4	4	5	6	5.5
5	4	5	5	5
6	2	2	2	2
7	5	3	4	3.5
8	3	4	3	3.5
9	3	3	4	3.5
10	4	4	4	4
11	3	5	4	4.5
12	2	2	2	2
13	3	5	6	5.5
14	3	3	3	3
15	3	5	5	5
16	4	6	6	6
17	4	5	5	5
18	4	4	3	3.5
19	3	3	3	3
20	4	5	6	5.5
21	2	3	3	3
22	7	7	7	7

Table 4: Chewing Gum Satiety.

Methods

Experimental protocol was that of experiment 3, using Wrigley's Extra Dessert Delight Apple Pie Sugar-Free Gum as a model and a slice of apple pie as the standard.

Market Pantry Apple Pie (Target Brand) is 2,280 calories. Cut into 23 equal slices, each slice contained approximately 100 calories. This level of calorie was chosen to conform with prior studies [18,25,28,29].

Selection criteria of volunteers were based on no restriction with regard to chewing gum or eating pie and were recruited as per experiment three protocols. Subjects ranged from 13 to 16 years old (average 13.8). Thirteen were girls and 11 were boys. None experienced negative hedonics toward the gum or pie tested.

Satiety index was assessed as per experiment three.

Statistical significance was determined using the 2-tail sign Test with statistical significance determined at $p < 0.05$ [26,27].

Thus, each person served as their own control, the independent variables were mastication of the Wrigley's Extra Dessert Delight Apple Pie Sugar-Free Gum and consumption of a 100 calorie slice of apple pie, and the dependent variables were the satiety values of the gum and the apple pie.

Results

Subjects were dichotomized based on whether they underwent testing first with gum or with apple pie. Satiety indexes were compared for gum tested first as compared to second. If no statistically significant difference was seen, it would suggest the absence of an effect of order of presentation. The same analysis was also performed for apple pie first versus second. No statistically significant difference was seen using the 2-tail sign Test for paired difference between means for the satiety indexes. For gum first, the average satiety index was 0.8125 for gum, and 0.75 for pie. For pie first, the average satiety index was 0.4688 for pie, and 0.9588 for gum. For pie first then gum, $p = 1.00$. For first gum then pie, $p = 0.065$. These results demonstrate that the order of presentation was not the cause of the findings.

In the combined groups (both gum and pie first), the average satiety index for gum equals 0.917, and for pie, it equals 0.563, the paired difference of which was not a significant difference (2-tailed p value = 0.096). Thus, the mean satiety value of Wrigley's Extra Dessert Delight Apple Pie Sugar-Free Gum is not statistically different from the mean satiety value of a 100 calorie slice of apple pie (Table 6A-6C,7A-7C and 8).

The results of the sign Test show that there is no statistically

Bread Satiety Level Based on Visual Analog Scale categorized 1-7 as per Illustration 1				
Subject	Initial	15mins	30mins	AUC (average of satiety level at 15 & 30 minutes)
1	4	3	4	3.5
2	2	3	4	3.5
3	4	4	3	3.5
4	6	6	6	6
5	6	5	3	4
6	1	1	1	1
7	3	3	2	2.5
8	4	5	6	5.5
9	3	4	4	4
10	3	4	4	4
11	4	5	4	4.5
12	2	3	3	3
13	1	3	2	2.5
14	2	2	2	2
15	4	4	5	4.5
16	4	6	6	6
17	4	5	6	5.5
18	1	3	4	3.5
19	2	2	2	2
20	4	4	5	4.5
21	3	5	5	5
22	6	6	6	6

Average initial satiety level = 3.3. Average AUC = 3.9.

Table 5: White Bread Satiety.

significant paired-difference between the satiety index for gum and the satiety index for pie in the group that was exposed to gum first ($p < 0.05$).

Using the sign Test, 2-tailed p -value = 0.065. The results of the sign test show that, for a 2-tailed test, the paired-difference values of the satiety index for gum minus the satiety index for pie are not statistically significant ($p < 0.05$).

Using the sign Test, and 2-tailed p -value = 0.096. These p -value results of the sign Test show that there is not a statistically significant paired-difference between gum satiety and pie satiety using a 2-tailed test ($p < 0.05$).

This statistical test demonstrates that the satiety index for a slice of apple pie and this flavored chewing gum are not significantly different from each other. The null hypothesis was accepted: the satiety indices of these two were statistically equivalent.

General Discussion

Hedonically positive popular isoenergetic confections have a hierarchical influence on long-term satiety as determined by the satiety index. The reason for this is unknown, but may have to do with chemosensory influence [30,31]. For instance, Starbursts have a 40%

greater satiety value than Tootsie Rolls. Yet, on casual inspection, these candies seem very similar. Tootsie Rolls and Starbursts both are individually packaged with multiple packages per portion, and are grossly similar in terms of texture, chewiness, and sweetness. However, Starbursts, unlike Tootsie Rolls, possess different flavors with each portion, and thus, a more diverse chemosensory experience. This suggests that sensory induced satiety may be an important element in production of the satiety index. This can be investigated further by testing other foods with similar calorie and varying sensory characteristics

Hedonically positive commercially available sugar-free gums demonstrated a hierarchical influence on long-term satiety. This may be due to both chemosensory and kinesthetic influences [30,31]. Expanding the procedure to a greater variety of gums and foods may allow for the development of a “children’s satiety index” which ultimately, may have utility as part of a child’s weight control program. The equivalent satiety value of all gums tested suggests that it is the action of chewing the gum, more than the intrinsic properties of the gum itself, which has the satiating properties. Furthermore, that satiety

Subject Number	Satiety at time = 0	Satiety at time = 15	Satiety at time = 30	AUC = $t_{15} + t_{30} - 2$	Satiety Index = AUC – time (0)	Gender	Age
1A	3	4	2	3	0	M	14
2A	1	5	5	5	4	F	16
3A	3	2	2	2	-1	M	15
4A	3	3	4	3.5	0.5	M	14
5A	2	5	3	4	2	M	14
6A	4	4	4	4	0	M	14
7A	6	6	6	6	0	M	15
8A	3	4	4	4	1	F	15
AVERAGE	3.125	4.125	3.75	3.9375	0.8125		14.625

6A of Gum

Subject Number	Time = 0	Time = 15	Time = 30	AUC	Satiety Index
1A	5	7	6	6.5	1.5
2A	1	3	5	4	3
3A	3	2	1	1.5	-1.5
4A	5	6	6	6	1
5A	3	4	5	4.5	1.5
6A	4	4	5	4.5	0.5
7A	6	6	6	6	0
8A	4	4	4	4	0
AVERAGE	3.875	4.5	4.75	4.625	0.75

6B of Gum

Subject Number	GUM Satiety Index	PIE Satiety Index	Paired Differences GUM S.I. – PIE S.I.	Sign of Paired Difference (+, -, or 0)
1A	0	1.5	-1.5	-
2A	4	3	1	+
3A	-1	-1.5	0.5	+
4A	0.5	1	-0.5	-
5A	2	1.5	0.5	+
6A	0	0.5	-0.5	-
7A	0	0	0	0
8A	1	0	1	+

(4 +s, and 3 –s. Ignore the 0.) Using the SIGN Test, 2-tailed p -value = 1.00.

6C Calculated Results

Table 6: Satiety Values Gum First, Pie Second.

Subject Number	Satiety at time = 0	Satiety at time = 15	Satiety at time = 30	AUC= t15+ t30-2.	Satiety Index = AUC – time (0)	Gender	Age
1B	2	3	2	2.5	0.5	M	13
2B	2	3	2	2.5	0.5	F	14
3B	2	1	1	1	-1	F	14
4B	2	4	5	4.5	2.5	M	13
5B	3	3	3	3	0	M	13
6B	2	2	1	1.5	-0.5	F	14
7B	3	4	5	4.5	1.5	F	13
8B	2	4	4	4	2	F	14
9B	4	6	5	5.5	1.5	F	13
10B	5	6	6	6	1	F	14
11B	3	4	4	4	1	F	13
12B	4	3	3	3	-1	F	14
13B	2	3	3	3	1	F	13
14B	3	2	1	1.5	-1.5	M	14
15B	1	1	1	1	0	M	13
16B	2	2	2	2	0	F	13
AVERAGE	2.625	3.1875	3	3.0938	0.4688		13.437

7A of Pie

Subject Number	Time = 0	Time = 15	Time = 30	AUC	Satiety Index
1B	2	2	2	2	0
2B	1	2	2	2	1
3B	2	1	1	1	-1
4B	1	63	6	6	5
5B	3	3	3	3	0
6B	3	3	2	2.5	-0.5
7B	3	5	5	5	2
8B	3	3	2	2.5	-0.5
9B	2	5	3	4	2
10B	3	5	6	5.5	2.5
11B	2	4	4	4	2
12B	4	5	5	5	1
13B	2	3	3	3	1
14B	3	4	3	3.5	0.5
15B	1	1	1	1	0
16B	3	3	4	3.5	0.5
AVERAGE	2.375	3.4375	3.25	3.3438	0.9688

7B of Gum

Subject Number	GUM Satiety Index	PIE Satiety Index	Paired Differences GUM S.I. – PIE S.I	Sign of Paired Difference (+, -, or 0)
1B	0	0.5	-0.5	-
2B	1	0.5	0.5	+
3B	-1	-1	0	0
4B	5	2.5	2.5	+
5B	0	0	0	0
6B	-0.5	0	0	0
7B	2	0.5	0.5	+
8B	-0.5	-2.5	-2.5	-
9B	2	0.5	0.5	+
10B	2.5	1.5	1.5	+
11B	2	1	1	+
12B	1	2	2	+
13B	1	0	0	0
14B	0.5	2	2	+
15B	0	0	0	0
16B	0.5	0.5	0.5	+

7C Calculated Results

(9 +s, and 2 –s. Ignore the 0s.)

Table 7: Satiety Values Pie First, Gum Second.

Subject Number	GUM Satiety Index	PIE Satiety Index	Paired Differences GUM S.I. – PIE S.I	Sign of Paired Difference (+, -, or 0)
1A	0	1.5	-1.5	-
2A	4	3	1	+
3A	-1	1.5	0.5	+
4A	0.5	1	-0.5	-
5A	2	1.5	0.5	+
6A	0	0.5	-0.5	-
7A	0	0	0	0
8A	1	0	1	+
1B	0	0.5	-0.5	-
2B	1	0.5	0.5	+
3B	-1	-1	0	0
4B	5	2.5	2.5	+
5B	0	0	0	0
6B	-0.5	-0.5	0	0
7B	2	1.5	0.5	+
8B	-0.5	2	-2.5	-
9B	2	1.5	0.5	+
10B	2.5	1	1.5	+
11B	2	1	1	+
12B	1	-1	2	+
13B	1	1	0	0
14B	0.5	-1.5	2	+
15B	0	0	0	0
16B	0.5	0	0.5	+
	Mean = 0.917	Mean = 0.563	Avg paired difference = 0.354	
	Standard deviation = 1.479	Standard deviation = 1.182	Standard deviation = 1.088	
	t (23d.f.) = 3.036	t (23d.f.) = 2.331	t (23d.f.) = 1.594	
			2-tailed p-value = 0.1234	

(13 +s and 5 –s. Ignore the 0s.)

Table 8: Combined Data Analysis for Gum first and PIE first Groups (n=24).

from gum is equal to that of white bread, but with 1/20th the number of calories, suggests that chewing sugar-free gum should be considered as part of the therapeutic armamentarium in treatment of obesity in children. In light of the current crisis of childhood obesity, further exploration into this arena is warranted.

Limitations of Findings

Findings have to be considered with reference to subjects' selected and food assessed. While subject size was more than quadruple that of the original published reference [18], a larger sample size would have been preferred. Subjects were from suburban Chicago and thus were not geographically or demographically diverse. Different results may have been found in other geographic regions in the US. Likewise, different age groupings of children may present with alternative satiety index scores. Like so many other physiological parameters which change throughout childhood and adolescence, the satiety value of foods or gums consumed or masticated by a five year old may not be identical to that of a 17 year old.

The food or gums chosen to evaluate may have influenced the results. Non-confectionary foods and high calorie gums were not evaluated, and this may have provided additional important satiety index values. The total calories provided in our study were approximately one half of that of Holt in the candy study and 1/40th in the gum studies [18]. We

don't believe this had any substantial influence since the satiety index we found closely resembled the confectionary satiety index of Holt's. Part of the rationale for choosing the candies and gums in the study was the authors' hedonic preference. It is unknown to what degree hedonics influence satiety index. This deserves further exploration.

Experimental Error

There are several sources of possible experimental error. Experimental design mandated a period of fasting prior to initiation of study. While not at lunch, it is possible students secretively may have eaten during these food-free class periods. If this happened, initial hunger may have been less, and a ceiling effect may have occurred and thus, true gum or pie-induced satiety may have exceeded what was actually recorded. The Hawthorne Effect may have also skewed data. The Hawthorne Effect is whereby the mere act of observation and recording, effects results [32]. Forcing subjects to record their level of satiety, may in and of itself, have influenced their levels of satiety. Further evidence for the presence of this may be extrapolated from the study of Morewedge's which found that imagining eating a food, in and of itself, induces a reduction in desire to eat that food [33]. However, such an effect should have influenced the pie, bread, and the gum equally. No effect of stage in menstrual cycle for female subjects was controlled for. This may be relevant since such hormonal changes can affect satiety [34]. This is unlikely in this sample since one would

not anticipate all female subjects to be at the same stage. Moreover any hormonal changes would have affected satiety assessment of the food and gum equally in each individual.

Conclusion

In children candy bars show distinct levels of satiety indices. The multi-flavored, different sensory stimulating and tensile nature Starbursts led to further investigation of gums with varying sensory characteristics. Chewing gum is as satisfying as white bread, with 1/20th the caloric intake. Further exploration showed that the action of chewing was responsible for equal satiety values across several flavors of chewing gum. When comparing satiety values of the chewing gum to white bread, the satiety values were found to be equivalent. Similarly, chewing a piece of apple pie flavored gum was as satiating as eating a 100 calorie slice of apple pie. Chewing sugar-free gum should be considered as part of the therapeutic approach in the treatment of obesity in children. In light of the current crisis of childhood obesity, further exploration into this arena is warranted.

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