Available online at www.sciencedirect.com
SCIENCE DIRECT
Appetite 47 (2006) 107–110
Appetite
www.elsevier.com/locate/appet

Short communication

The sweet tooth hypothesis: How fruit consumption relates to snack consumption

Brian Wansink[a,*], Ganaël Bascoul[b], Gary T. Chen[c]

[a]110 Warren Hall, Cornell University, Ithaca, NY 14853, USA
[b]HEC, Cergy, FRANCE
[c]University of Pennsylvania, Philadelphia, PA, USA

Received 28 January 2004; received in revised form 7 July 2005; accepted 22 July 2005

Abstract

Building on prior work related to taste preferences of fruit lovers, we investigate the "sweet tooth" hypothesis. First, using CSFII survey data, we show that fruit consumption is more highly related to sweet snack consumption than it is to salty snack consumption. Second, a follow-up study with a different population supports the relationship by showing that sweet snack consumption is more related to fruit consumption than it is to vegetable consumption. Knowing that people who frequently eat sweet snacks may be predisposed to increasing their fruit consumption will enable better targeting and tailoring of educational efforts, such as those used in the 5-a-Day for Better Health campaign.

Keywords: Fruit and vegetables; Five-a-day; Sweet snacks; Salty snacks; Taste profiles

Introduction

In the fruit and vegetable world, fruits are relatively sweet. The "sweet tooth" hypothesis states that many people have a strong liking for sweet tastes, and a consequence of this may be that people who frequently eat sweet snacks may also frequently eat fruits. If this is true, it would hold a key as to how to encourage greater fruit consumption among sweet snack lovers who may have a latent or unrealized predisposition toward fruit (Wansink, 2005).

People consistently report that taste—sweetness in particular—is an important factor influencing their fruit selection and consumption (Neuhouser et al., 2000). If a link between sweet snacks and fruits exists, it could enable us to better predict who will be most receptive to fruit-focused nutrition education efforts. Furthermore, it could indicate what food substitutions have to occur before these latent fruit lovers can increase their fruit consumption, thereby reducing their calorie intake and improving their health (Serdula et al., 1996).

The sweet tooth hypothesis can refer to either preference or consumption frequency. The first suggests a high correlation between the *liking* for sweets and for that of fruit. The second suggests a high correlation between the *consumption frequency* of sweets and for that of fruit.[1] Because of the concern that nutritional programs have with encouraging more frequent consumption, the primary focus of this research is on consumption frequency.

Study 1. Sweet snack lovers eat more fruits than salty snack lovers

Study 1 uses a nationally representative survey to investigate whether fruit consumption is more strongly related to sweet snack consumption than to salty snack

[1]Preference and consumption frequency are not equivalent. Ecological factors (such as the availability of sweet snacks) might interfere with the consumption frequency correlation, but leave a liking or preference correlation intact. Furthermore, because sweet snacks and fruit can both double as desserts, a frequency correlation might even be negative in a community with low frequency of snacking.

*Corresponding author.
E-mail address: Wansink@Cornell.edu (B. Wansink).

0195-6663/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.appet.2005.07.011

consumption. It could be that people who eat a large quantity of fruits eat a large quantity of all foods. However, if the sweet tooth hypothesis is correct, fruit consumption will be related more strongly to sweet snack consumption than to salty snack consumption.

Method

To examine the relation between fruit consumption and snack consumption, we used national survey data from the USDA's Continuing Survey of Food Intakes by Individuals (CSFII) taken during the years of 1994–1996 (USDA, 1998). The CSFII is a dietary intake survey consisting of demographic information and two consecutive days of 24 h dietary recall (midnight to midnight) obtained by trained interviewers from a national sample of 7522 households observed over 2 days. The Day-1 and Day-2 recalls begin with the sample person being asked to report everything eaten or drunk the previous day. In the case of pre-teens, a parent was asked to report for them. The average number of individuals sampled in each household is 1.9, leading to a total of 14,292 (1.9×7522) individuals in the data set. The data set included information about the type and amount of food consumed along with information about the timing of consumption and eating occasion (meal, snack and so on). In this study we focus on consumption frequencies. Therefore, a fruit and a small sweet snack would be considered as two different intakes while a large sweet snack would be considered as one.

Respondents were 52.3% females, lived in a household with an average of 2.87 people (SD = 1.57) and had an average age of 39.4 yr (SD = 24.7). Each day, the average respondent ate 2.11 servings of fruit (SD = 2.59), 3.07 of sweet snacks (SD = 2.99) and 3.29 of salty snacks (SD = 2.89). "Fruits" included all types of fruits (according to the conventional definition of fruits), and "sweet snacks" included all types of sweet snacks, including ones such as sweets, sugar, candy, cakes, cookies, pastries, pies, quick breads, pancakes and ready-to-eat cereals.[2]

As conventionally recommended in consumer panel studies (Sudman & Wansink, 2002), each day was examined as a different data point. The day was the basic metric for two main reasons. First, daily consumption behavior is consistent with the focus of campaigns such as 5-a-Day for Better Health Program. Second, using daily consumption behaviors avoided the potential compensation effects that would occur by averaging across two dissimilar days (such as Friday and Saturday). For each household, the consumption of up to two individuals was taken in to account for each of the 2 days, which could include both weekdays and weekends These four correlations were determined using SPSS statistical software (version 11.0), and the average of these four correlations will be used as a summary measure. The differences between correlations were conservatively tested using unrelated individuals.

Results and discussion

As the sweet tooth hypothesis would suggest, the average consumption frequency of fruits was significantly correlated ($r = 0.40$) with the frequency of consumption of sweet snacks (Table 1). Fruit consumption was also correlated ($r = 0.35$) with salty snack consumption. A test of the difference of correlation coefficients indicated the correlation with sweet snacks was stronger than with salty snacks [$t(75220) = 3.05$; $p < 0.025$].

In addition to the Pearson correlation, a correlation of incidence (Yule's Q) was conducted using binary measures of consumption incidence for fruits, sweet snacks and salty snacks across all individuals in a household across both days. Incidence was coded as a 1 if anyone in the house had a fruit on a particular day, and zero if they did not. A correlation of incidence is less sensitive to outliers, and the correlation between fruit and sweet snack consumption was $r = 0.43$, whereas the correlation between fruit and salty snack consumption was $r = 0.30$ ($p < 0.01$). This measure of incidence is determined for a given day and it measures the co-occurrence between two types of consumption. In doing so, both days were combined into an overall indicator of consumption incidence.

Basic regression analysis (using each day for both family members) was used to determine the relative strength of how sweet snack and salty snack consumption relates to fruit consumption. The R^2 of the model was 0.19 ($p < 0.001$). The standardized coefficients indicate that while both sweet snack consumption and salty snack consumption related to fruit consumption (0.27 vs. 0.23) the impact of sweet snacks was stronger than the impact of salty snacks [$t(15.04) = 3.71$, $p < 0.01$]. An alternative

Table 1
Correlations (r) of fruit consumption with sweet snack consumption and salty snack consumption

	Fruit and sweet snack	Fruit and salty snack	N
Day 1: household person #1	0.42	0.36	3850
Day 1: household person #2	0.38	0.34	3849
Day 2: household person #1	0.42	0.38	3672
Day 2: household person #2	0.38	0.32	3663
Mean r-value	0.40	0.35	—

All r-values have $P < 0.001$.
Difference between means has $t(6) = 3.05$, $P < 0.025$.

[2]It should be noted that if one person eats a large sweet snack every day, and another eats a small snack, both would be defined as one and the same event. It would be biasing to compare across the amounts eaten because the average intake varies dramatically across the type of food being considered. Furthermore, consumption frequency is investigated because it describes the consumption "reflexes" during a day, and corresponds to whether a person who is hungry will choose something salty or sweet to eat.

explanation to the sweet tooth hypothesis is that someone who consumes a great deal of fruits might simply have a large appetite and may consume a great deal of *all* snacks. To account for this, fruit consumption was regressed on the total number of snacks consumed each day and on binary measures of incidence for sweet snacks and for salty snacks (1 if eaten, 0 if not). The R^2 of this regression was 0.17 ($p<0.01$) and the standardized coefficient for sweet snacks was 0.08 ($t=10.7$; $p<0.01$) and that for salty snacks was 0.04 ($t=4.92$; $p<0.01$). After accounting for total snack consumption, the impact that sweet snack consumption had on fruit consumption was more than twice the impact that salty snack consumption had [0.08 vs. 0.04; $t(15{,}037)=9.53$, $p<0.01$].

People who were frequent consumers of fruit were also frequent consumers of sweet snacks. While the frequent consumption of fruit was also correlated with that of salty snacks, this relationship was not as strong as it was with sweet snacks. Yet to further investigate this, it would be useful to know if sweet snack consumption relates with fruit consumption more than with other foods, such as vegetables.

Study 2. Fruit lovers eat more sweet snacks than vegetable lovers

To complement the CSFII investigation and to better assess the reliability of this fruit-sweet snack relationship, a follow-up study was designed to determine whether sweet snack consumption was related more strongly to fruit consumption than to vegetable consumption. After assessing one's liking for fruits or vegetables (which the CSFII data did not do), we wanted to know whether self-rated fruit lovers ate more sweet snacks than self-rated vegetable lovers. If the sweet tooth hypothesis is correct, fruit consumption will be related more strongly to sweet snack consumption than to salty snack consumption.

Method

A survey was mailed to a random sample of 2000 North Americans along with an honor check of $6.00 that they could cash if they completed the survey. Within a 6 week period 770 (38.5%) responded and were included in the study. Respondents were 61.0% female, lived in a household with an average of 3.1 people (SD = 1.83), were 70.2% Anglo-American and had an average age of 37.3 yr.

In the survey, respondents were given a list of 12 common fruits and vegetables, eight sweet snacks and eight salty snacks and asked to indicate how many times they had consumed each in the prior week. These were general category exemplars (apples, potato chips, candy bars and so on). They were asked to use nine-point Likert scales (1—strongly disagree; 9—strongly agree) to indicate the extent to which they had a strong preference for fruit ("I have a strong preference for fruit") and the extent to which they had a strong preference for vegetables ("I have a strong preference for vegetables"). This could have also been asked using nine-point scales of liking (1—dislike extremely; 9—like extremely). While a measure of liking would have been more conventional, it was believed that forcing a preference would help to better differentiate fruit lovers and vegetable lovers. Unlike conventional measures of liking, using a force choice question such as this has been shown to be more sensitive in differentiating between two items that are both well-liked (Bradburn, Seymour, & Wansink, 2004).

Results and discussion

Consistent with studies involving heavy users (Wansink & Park, 2000) and those with extreme preferences (Wansink, Sonka, & Park, 2004), we took the average consumption frequency for the six fruits and for the six vegetables. We then compared the top third of those individuals who most preferred fruit (fruit lovers) with the top third of those non-overlapping individuals who most preferred vegetables (vegetable lovers). Of the 770 respondents, 405 were included in the study because they had a relatively stronger preference for either fruits or for vegetables (a two scale point or greater difference). By analyzing only those with a relatively stronger preference for either fruits or for vegetables (not both), independent samples could be analyzed.

When comparing the snack consumption between the two groups, it was found that fruit lovers recalled more frequently eating sweet snacks compared to vegetable lovers [15.1 vs. 10.8 times per week; $t(403)=14.5$, $p<0.01$]. This is also consistent with the overall correlations between the consumption patterns of all individuals. The correlation between sweet snack consumption and fruit consumption was higher than that for sweet snack consumption and vegetable consumption ($r=0.26$ vs. $r=0.13$; $z=4.74$, $p<0.01$).

In contrast to sweet snack consumption, fruit lovers were no more likely to recall consuming salty snacks then were vegetable lovers. In fact, the opposite appears to be the case. While fruit lovers ate salty snacks 11.3 times per week, vegetable lovers ate them 15.1 times [$t(403)=5.2$, $p<0.01$)].

The results of both of these studies are consistent and triangulate on the "sweet tooth" hypothesis regarding sweet foods and fruit. That is, since fruit generally tastes sweeter than vegetables, we would expect fruit lovers to have more of a sweet tooth and that this would be evidenced in more frequent consumption of sweet snacks. Indeed, Study 1 shows that sweet snack lovers eat more fruits than salty snack lovers. Study 2 shows that fruit lovers eat more sweet snacks than vegetable lovers.

Implications

Food preferences are not independent of each other. If we know a person likes one type of food, we are better able

to predict what other types of foods he or she might prefer (Wansink & Westgren, 2003; Wansink & Cheong, 2002). Understanding these taste or preference covariances enables us to better determine why, e.g., fruit lovers tend to eat sweet snacks. This, in turn, helps us better understand what drives the consumption frequency of various foods (Raudenbush, Van Der Klaauw, & Frank, 1995). For instance, to identify those who may be predisposed to increasing their fruit consumption, people who frequently eat sweet snacks should be considered. Compared to a salty snack lover, those who eat sweet snacks are more likely to have a taste profile that mirrors that of frequent fruit consumers.

Most studies on fruits and vegetables have focused on infrequent consumers of fruit (Laforge, Greene, & Prochaska 1994; Thompson, Margetts, Speller, & McVey, 1999) instead of on frequent consumers (Brug, Lechner, & De Vries, 1995). Knowing some general food preferences and eating habits of fruit lovers gives us a better idea of how to target and educate those who show similar predispositions but who are currently infrequent consumers of fruit. Indeed, to improve the effectiveness of programs such as the 5-a-Day for Better Health Program (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003), taste profiles can be developed for both frequent consumers of fruit and of vegetables (Satia et al., 2002).

Exploratory efforts have shown that vegetable lovers, for instance, enjoy cooking, entertaining and using new recipes more than fruit lovers (Wansink & Lee, 2004). In a similar way, comprehensive taste profiles for various subsegments of fruit lovers and vegetable lovers might provide useful insights that would lead to more effective message strategies that are more efficiently targeted. An initial suggestion in this direction would be to analyze the marketing strategies of sweet snacks (such as candy bars) and incorporate these techniques into an intervention program (5-a-Day for Better Health Program) to increase consumption of fruit.

Acknowledgements

Brian Wansink is the John S. Dyson Professor of Marketing and of Nutritional Science at Cornell University. Ganael Bascoul is a Ph.D. student at HEC (Cergy, France), and Gary T. Chen is a Ph.D. student the University of Pennsylvania.

The authors would like to thank the Council of Agricultural Research at the University of Illinois and INSEAD for their support of this research.

References

Baranowski, T., Cullen, K. W., Nicklas, T., Thompson, D., & Baranowski, J. (2003). Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obesity Research*, *11*, 23S–43S.

Bradburn, Norman, M., Seymour Sudman, & Brian Wansink (2004). *Asking questions: the definitive guide to questionnaire design—for market research, political polls, and social and health questionnaires*. San Francisco, CA: Jossey-Bass.

Brug, J., Lechner, L., & De Vries, H. (1995). Psychosocial determinants of fruit and vegetable consumption. *Appetite*, *25*, 285–296.

Laforge, R. G., Greene, G. W., & Prochaska, J. O. (1994). Psychosocial factors influencing low fruit and vegetable consumption. *Journal of Behavioral Medicine*, *17*(4), 361–374.

Neuhouser, M., Patterson, Rl., Kristal, A., Rock, C., Neumark-Sztainer, D., Thornquist, M., et al. (2000). Do consumers of savory snacks have poor-quality diets? *Journal of the American Dietetic Association*, *100*(5), 576–579.

Raudenbush, B., Van Der Klaauw, N. J., & Frank, F. (1995). The contribution of psychological and sensory factors to food preference patterns as measured by the Food Attitudes Survey (FAS). *Appetite*, *25*, 1–15.

Satia, J. A., Kristal, A. R., Patterson, R. E., Neuhaouser, M. L., & Trudeau, E. (2002). Psychosocial factors and dietary habits associated with vegetable intake. *Nutrition*, *18*(3), 247–254.

Serdula, M. T., Byers, T., Mokdad, A. H., Simoes, E., Mendlein, J. M., & Coates, R. J. (1996). The association between fruit and vegetable intake and chronic disease risk factors. *Epidemiology*, *7*, 161–165.

Sudman, S., & Wansink, B. (2002). *Consumer panels* (2nd ed.). Chicago: AMA.

Thompson, R. L., Margetts, B. M., Speller, V. M., & McVey, D. (1999). The Health Education Authority's Health and Lifestyle Survey 1993: Who are the low fruit and vegetable consumers? *Journal of Epidemiology and Community Health*, *53*, 294–299.

USDA. (1998). *Continuing survey of food intakes by individuals from 1994–1996*. Washington, DC: Agricultural Research Service.

Wansink, B. (2005). *Marketing nutrition: soy, functional foods, biotechnology, and obesity*. Champaign, IL: University of Illinois Press.

Wansink, B., & Cheong, J. H. (2002). Taste profiles that correlate with soy consumption in developing countries. *Pakistan Journal of Nutrition*, *1*(6), 276–278.

Wansink, B., & Lee, K. (2004). Cooking habits hold the key to 5-a-Day success. *Journal of the American Dietetic Association*, *104*(11), 1648–1650.

Wansink, B., & Park, S. B. (2000). Methods and measures that profile heavy users. *Journal of Advertising Research*, *40*(4), 61–72.

Wansink, B., & Westgren, R. (2003). Profiling taste-motivated segments. *Appetite*, *41*(3), 323–327.

Wansink, B., Sonka, S. T., & Park, S. B. (2004). Segmentation approaches that differentiate consumption frequency from sensory preference. *Journal of Sensory Studies*, *19*(4), 327–340.