A study of Food Consumption by Carnegie Mellon's Computer Science department
(or: observations of Bagel decay)

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Abstract— **Among the many uses for Web cams, one of them is for the detection of free food. It has been said that the intersection of under-funded graduate students and over-worked, under-socialized computer scientists is the kitchen counter at which such free food is left. In this study, we attempt to analyze the rate at which free food placed on such a counter is consumed among a population of graduate student computer scientists. We report on the behavior of such people to the presence of various types of free food. In addition to food presented in the natural course of events, we lay out sliced bagels at various times and various amounts over a one week period capturing consumption rates at various time intervals. We were able to find a correlation in the consumption of bagels in our study. Even in the presence of covariates, it appears that the log of the percentage consumed remains the same for bagels initially presented within a forty-five minutes window beginning at 10:00am.**

I. INTRODUCTION

While many web cameras observe the coming and goings of people or cars, a web camera in the graduate student lounge of Carnegie Mellon's Computer Science Department ("CSD", Wean Hall, 4th Floor) is both placed within, and is to observe, food [2]. Mounted inside a vending machine of soft drinks and water, it is pointed at a table on which extra food is often placed. This enables those fully engaged in their work, even those with remote offices, to be quickly altered to the presence of free food. We present preliminary evidence for a food consumption rate at various times.

From a cursory web search, it appears that the CSD is not alone among CS departments in its use of web cams to monitor food in some way [1]. Beyond its humorous effect, it does serve a useful purpose: 1) extra food from that day's meetings appears to not be wasted; 2) graduate students, already on tight budgets get regularly occurring benefit in free food (that might even be of better quality than what they were otherwise having). Among the downsides is that it might contribute to poor health by encouraging food consumption especially among heavy computer users [3].

We have several questions, the answer to which is hinted at in this study and may be explored in further research. Consider the presence of whole plain bagels every day in the student lounge. Over time, would consumption go up as more people hear about its presence and come regularly to collect their bounty? It might just as well drop as people tire of the plain bagels and look for different food. Its regular presence might also encourage those with extra food to deploy it elsewhere as the CSD lounge is known to already be well-stocked. The most interesting hypothesis to emerge from this study for dedicated experimentation is the possibility that the rate of consumption does not vary in a predictable way for any quantity of free food (i.e., in the presence of restricted supply, people hoard, but in the presence of constant, abundant supply, consumption decreases).

A. Other questions

Other questions might include: what would happen to consumption if the bagels were sliced? What if the bagels were garlic or salt (two of the least popular varieties)? What if the variety of the bagel rotated? What if the quantity varied? How does the presence of other food, or day of the week, or time of the day, effect the rate of consumption? Over a large period of time involving a large sample size, this is easier to determine. While in this experiment we produced statistically significant results, the small data set merely suggests behavior in which we may delve further. The work described in this paper will present our findings and suggest some designs for future experiments.

B. Practical applications

This study may motivate further investigation for any number of reasons. Chief among them may be the appropriate ordering of food for meetings and conferences. If we can predict the rate at various times at which extra food will be consumed in the graduate student lounge, we know the time at which we must move food to the lounge for it not to be wasted. We might also learn of other locations at which extra food may be placed.

Perhaps more importantly, but more subtle, we might be able to optimize the presence of free food to increase social interaction, improve morale, or increase productivity by encouraging one's presence at the office (e.g. food at irregular intervals early or late in the day). Anecdotal evidence gathered by our researcher provides evidence that the presence of the food could be used to manipulate all of these behaviors.

We came to discover that the CSD webcam is either not easily available or not reliable. Access is to be restricted to those

within specific departments of Carnegie Mellon in addition to CSD [1]. This restriction demands a login over the VPN of that department. Even then, we found our access to be unreliable. Our researcher was unable to access the webcam at various times in the study. There is a video screen on the coke machine in which the camera is mounted. This video screen shows, among other things, the product of the video shot by the camera in real time. On the final day of our research, even this screen showed an identical 'access forbidden' error message to that observed by our researcher.

TABLE 1
BAGEL PIECES REMAINING

Day Start time	Tues. 10:00	Wed. 10:45	Thurs. 9:20	Fri. 10:45	Fri. 15:30
Time (min.)	72	96	48	80	61
0	72	96	48	80	61
15				48	
20			24		
30	57	68		38	
35			10		
45				34	
60				32	
65		37			
70			0.01		
75				26	28.5
90				20	22.5
100		1			
105				13.5	20.5
120	0.01			8.5	20.5
135				1.5	15.5
150					15.5
165					13.5
180					9

Half units are created by subjects' ripping piece in two. Two half pieces were counted as one piece

A surprising number of confounding variables (covariates) will inform further research. Equally surprising is that this study found a strong correlation between consumption even in the presence of covariates. There is some anecdotal evidence to suggest that were the experiment to continue, an actual *decrease* in consumption might take place over that observed. However, this not necessary reflected in the consumption data.

II. METHODS

We purchased freshly made bagels (4) and presented them in the CSD lounge within thirty minutes of purchase (5, one exception).

A. Choice of Material

For our study, in food consumption, we chose Bagels as a food that was as neutral as possible in that 1) it isn't particularly temperature sensitive and therefore can be left exposed for reasonable periods; 2) it isn't particularly associated with a time of the day as some pastries might have been; 3) it is easy to take smaller or larger portions unlike, for example, donuts or pizza; 4) it is often sold as food as part of a meal unlike popcorn or candy; 5) day-to-day consistency is likely to be high

Once selecting bagels, we chose to increase available data sets by doing two things: 1) slicing the bagels into quarters in such a way that for each bagel, there are two bottom and two top pieces (i.e., one slice across, one slice down; 2) providing different varieties of bagels to judge if variety was a covariate worth exploring further.

B. Material Selection

We chose a local supplier, *The Pittsburgh Bagel Factory* (5885 Forbes Avenue, Pittsburgh, PA) because 1) it is the closest store to our experiment location allowing for fresh bagels; 2) it makes its bagels onsite allowing for consistent types of varying and independent quantities; 3) its independence from Carnegie Mellon diminishes the likelihood of awareness of the experiment becoming a covariate itself.

The first salesperson at The Bagel Factory told us that the most popular Bagel was the sesame and the least popular was the Garlic. On subsequent visits, we confirmed the sesame as being most popular and perhaps only the salt bagel rivaling the garlic bagel for least popular. This is evidenced by our final day's order of three-dozen bagels selling out their garlic bagel selection; the workers could not remember a time when this had happened. In addition to these two varieties, we added plain bagels as a control.

Even careful slicing does not result in physically or visually equal food pieces. Our researcher sliced all of the bagels on the first day. The next day, although The Bagel Factory sliced as requested, the slices were uneven. Each subsequent day, the slices were relatively even.

TABLE 2
REMAINING PIECES AS PERCENTAGE OF ORIGINAL

Day Start time	Tues. 10:00	Wed. 10:45	Thurs. 9:20	Fri. 10:45	Fri. 15:30
Time (min.)	72	96	48	80	61
0	100%	100%	100%	100%	100%
15					
20			50%		
30	79%	71%		48%	
35			21%		
45				43%	
60				40%	
65		39%			
70			0.02%		
75				33%	47%
90				25%	37%
100		1%			
105				17%	34%
120	0.01%			11%	34%
135				2%	25%
150					25%
165					22%
180					15%

C. Presentation Method

Every morning, we placed the bagels in the clear plastic lid of a catering dish on the table in the CSD lounge in plain sight of the webcam. We separated the bagel quarters to allow for

only one piece to be taken. Varieties were grouped together into the same tray.

D. Presentation Temporality

With one exception, at each presentation we laid out the bagels within thirty minutes of purchase (the exception being Friday afternoon—see Table 1). All bags were tightly sealed in advance of presentation to preserve freshness.

E. Data Collection

1) Method: At each time interval, we attempted to count the decease in overall consumption in addition to each variety. This was done with physical observation of the remaining slices.

2) Timing: We modified our observation timing during the experiment based on the results observed. The last three experiments involved observation at fifteen-minute intervals (see table 1). Some gaps remains due to limitations in our Researcher's schedule. These do not appear to have affected the end result.

III. RESULTS

A. Consumption

According to Table 1, we observed a steady decrease in available food, the predictable trend of which may not be easily observable. Table 2 suggests more interesting information as we see percentage of remaining food sections.

Taking ln (x) where x is the percentage of food remaining, we see a correlation at $\alpha=0.05$ for the three experiments run between 10:00 and 10:45am. We therefore have a statistically significant result to begin developing a model for bagel delivery in a forty-five minute window beginning at 10:00. We have anecdotal evidence that suggests starting earlier produces a steeper consumption curve while afternoon bagels have a much slower rate of consumption.

B. Covariates

On Tuesday, a bag of popcorn was present, by Wednesday, someone had placed a basket of jam next to the bagels along with a plastic knife. On Friday morning, we placed out an additional two pounds of candy (peanut M&Ms) to test the effect of other food on bagel consumption. The bowl into which the M&Ms were places was empty in forty-five minutes. On Friday afternoon, other food was present on the counter alongside the bagels some of which was being used as a spread on the bagels or as the middle of a bagel sandwich. Additionally, our researcher counted at least six food-oriented events in other parts of campus providing unusually visible alternatives.

C. Measurement

Bagel cutting On the size issue, our cutting methodology may have had an effect. Cutting across is a common practice to accommodate spreads of different kinds, but independent of further slicing, this method creates a more desirable top than bottom. Slicing in equal quarters like a pie may have appears unusual and harder to eat, affecting the study.

IV. DISCUSSION

The consumption of free food in the Carnegie Mellon University Computer Science Graduate Student Lounge appears to follow a predictable logarithmic decay as a percentage of the total originally available even in the presence of covariates. For further study, controlling for time of time day would the variable most affecting the current results. Varying the type of food and attempts to study other departments would also be interesting follow-up.
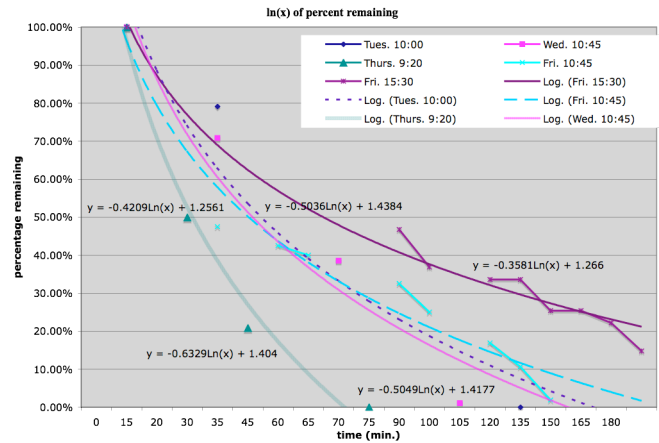
A. Results

Although we see a result with a statistically significant result, there remains some difficulty in the accuracy of this data for several reasons. Among them is data collection. Observing the bagel pieces accurately would have been desirable, but not possible unless an overhead camera was constructed.

Further, our original idea of tracking bagel type proved to be impossible. While visually, consumption appeared more less the same, the garlic and sesame fell off and attached it self to the other bagels in such a way that distinguishing them was nearly impossible. Further research might include some easily to distinguish varieties.

B. Experiment presentation

Future studies should keep the following in mind when designing experiments: i) *Counting progress:* Different bagel types should be placed in separate trays; ii) *Observation:* Our researcher was caught on Tuesday and questioned about 'the purpose' of the Bagels. Webcam-only observation is desirable; iii) *Varieties:* Changing foods might be interesting, especially at different times of the day. Presenting bagels, for example, with and without spread may give its own rewarding results; iv) *Slicing:* Slicing presents tops and sometimes less desirable bottoms. Bottoms should probably be thrown out if too thin; v) *Presentation:* We presented for functionality, but controlling for beauty of the presentation could be its own experiment. Even more interesting would be a presentation of food with a rotating sign in front such as 'please take only one' or the mischievous 'please do not touch'.

REFERENCES

[1] *This is a list of various coke or other vending machines that are accessible via the Internet. Other Internet accessible machines and*

other fun stuff are listed separately. [cited; Available from: http://www.cs.cmu.edu/afs/cs.cmu.edu/user/bsy/www/coke.html.

[2] *Coke machine webcam at CSD http://www.cs.cmu.edu/~coke/.*

[3] J.A., W.D.R.C.F.J.B.P.J.W.H.M.H.H.B., *Does television affect teenager's food choices.* Journal of Human Nutrition & Dietetics, 1997. **10**(4): p. 229-235(07).

[4] Seltman, H., *Experimental Design of Bagel Consumption*, E. Daimler, Editor. 2005: Pittsburgh, PA.