Big Data Insight Needs Sort

Formative Evaluation Study

October 2014

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This project was completed with support from the National Science Foundation (1223698).

Table of Contents

Introduction

To better help museum visitors make sense of large data sets, also called "big data", it would be invaluable to know if there are generalizable ways in which visitors engage with and then make meaning of such data sets. This front-end study was designed to explore if there are different, distinct, and repeatable patterns intuited by individuals as they work with large data sets.

The questions that guided this front-end study were:

How do museum visitors categorize large, multi-faceted data sets?
Are there patterns in how museum visitors categorize these data sets?
Are there patterns in how museum visitors make meaning from these data sets?
Are there patterns in how museum visitors determine "outliers" in the data?

To assist in this analysis, the probes included items that will help guide on two key subquestions:

- How do museum visitors make embedded comparisons and explain why similar items might occur in multiple categories?
- How do museum visitors explain the relationships between items based on their clusters (casual or relational links)?

To guide this evaluation, we also used the framework on "Insight Need Types" from the *Atlas of Knowledge (2014)* to help make sense of the findings.

Methods

This was a formative evaluation study, intended to reveal ways in which museum visitors make sense of large sets of data, with the hope that such findings could inform how to better facilitate visitor engagement with large data sets. This was a descriptive, process method using a complex card sort with an interview.

Population

The participants in this study were adult visitors to COSI (Columbus) and the Science Museum of Minnesota (St. Paul) during late July and August, 2014. There was originally a maximum of 75 participants at COSI and 35 at SMM. The final N was 74 at COSI and 11 at SMM for a total of 85.

Conditions

At COSI, the Experience Testing Station was set-up in the atrium with a café table surrounded by stanchions. The Whiteboard had the heading "How do you organize large data sets?" The lolly-pop sign had the Experience Testing Station template reading:

Today's study:	How people group large data sets
Method:	Card sort and interview
Purpose:	Help COSI (SMM) plan for a new experience
Audience:	Adults (18+)

At SMM, the card sort was conducted at a counter-space area on level 3 in the Experiment Gallery. This area is two floors away from the main entrance to the museum, which means that visitors approached to participate in the study were most likely mid-way through their museum visit. A letter size (8.5 x11 inch) sign was posted on the counter that read: "Research with Adults at the Science Museum of Minnesota" and "Today's project: Card Sort".

Recruitment

Participants were recruited in the middle of a visit. Individuals were approached using focal sampling with a continual ask. The following script was used for the recruitment:

Hi! My name is _____and I'm working with [COSI/SMM} on a study of visitors. [COSI/SMM] is working on a project and we are trying to find out how different people organize big data sets. Would you be willing to give me just a few minutes of your time to help us out? It shouldn't take more than 7 minutes of your time, and of course, you are free to respond or not to any question and withdraw at any time from the study.

If yes: Great! Over here I have a pile of cards that are all about food. I'd like you to organize these cards in a way that makes sense for you! You can even have subsets within the groups you create. There is no one way to organize them, so it truly is what seems right for you. When you're done, I have just a few questions for you.

If no: Thank you very much! Have a great day here at [COSI/SMM]!

Method

50 cards were created for the study—4.25"x 3.43" (8.5x11 divided into 6), printed, and laminated. Each card had the name of one food item written on it. Food items were diverse, including eggs, crackers, lasagna, apples, tofu and almonds. A complete list can be found in Appendix A. The choice of words was intentional with a goal of having foods that would disrupt simple categorization.

Participants were given the cards randomly shuffled. As the individual sorted the cards, the evaluator made notes about the approach using the ethogram (following). Upon completion, the evaluator took a photograph of the sorted cards upside down so the code numbers were shown in clusters.

Individuals were observed in how they conducted the sort, and then were prompted to discuss both the approach and the initial decision process. The interview schedule can be found in Appendix B.

Card Sort Ethogram

	Observation	Hesitation/Stop	Continue/change
Initial Approach Second approach Third approach If approach changes, note the change and begin new set of observation notes	Open notes	Pause with card Pause looking at cards Put aside card* Look at two+ cards* Shuffle through cards Ask question Engage another person Struggle with multiple options for a card*	No change Redo process completely Modify process* Blend stacks Divide stacks Shuffle all cards*

*Specific question for probe

Analysis

Analysis was for trends and patterns and also intended to compare those trends against the categories identified by Borner in the *Atlas of Science*. The *reasons* are of more importance than the actual categories. Analysis will be for trends and patterns. In addition to the notes, the photographs might be used to more deeply explore the contrasts in categories among visitors.

Results

There were two main methods the participants used to sort the cards:

Method 1. Sorting cards into emergent categories as the participants flipped through the stack of cards.

Method 2. Examining all cards, deciding on categories, and sorting cards based on these pre-determined categories.

Method 1

By far, the most common method was sorting cards into emergent categories. The majority of participants began preliminary sorting as they flipped through the stack of cards one by one. The participants would look at the data in front of them case by case and categories would emerge as they found similarities in prior cards. Usually, participants had no idea what food items would be revealed in the rest of the stack.

Participants tended to begin by sorting into food groups or meals. From these categories additional categories often emerged, including “drinks”, “junk” and “food I don’t like/don’t eat”.
Popular emergent categories included:

- Veggies
- Fruits
- Starches/Breads

- Meat (sometimes broadened to include dairy and tofu, once sub categorized into "junk meat" and "meat")
- Junk
- Drinks
- Breakfast
- Lunch

Method 2

The second approach, much less common, involved looking through the cards before sorting them. In this case the participant usually paused to formulate categories based on what they saw before combining cards that had similarities based on the (partially) determined scheme. For example, one couple with a young child looked at every card, and then formulated their categories so that their preschool child could help with the sorting.

Another individual spread all fifty cards out on the table and then combined cards into categories.

Another visitor flipped through the cards, acknowledged "they're all food" and then started making six categories. During the course of the sort, this individual flipped through the stack many times and would start multiple new piles, think about them, then combine piles. This person also moved things between piles several times but finally combined piles and kept the major categories that began the process.

These examples show the range of ways in which visitors examined the data before beginning analysis.

Other approaches

Some individuals sorted cards into areas, but not piles. This allowed the individual to move cards between the areas, and after struggling with the last five cards, then making the piles neater by pushing the cards together.

Other people acknowledged challenges, and reflected, as one individual commented, "I should have looked through them all first," even though they did not change their categories.

A small set of individuals would initially look through the cards (some or all), then sort into two groups, then subdivide into more discreet groups. One individual sorted into three categories, rethought, then kept the three categories. Another sorted into two piles which expanded to five piles. And then resorted one of those five into two for a total of six piles.

Several individuals used spatial orientation for organizing the data. Rather than piles, they used areas and then would move cards around the table. For example, one person had all the cards splayed across the table, then worked from right to left on the table, revising the system of coding.

Actions based on the Atlas of Science categories

Looking at Borner's comparison of scholars' Insight Needs Types, it would appear that the key categories of types are categorize, comparison, and order/rank/sort. In discussion, there were some comments related to trends and relationships, although these (and comparison), were generally superficial and not deep, even for the museum context. Distribution, compositions, geo-spatial, and relationships were generally absent in how people organized data and described their processes/thinking around doing so.

These findings suggest that the entry approach to making meaning for museum visitors reviewing large data sets is fairly superficial. Further, once individuals commit to an organization, they rarely critically reconsider the categories of organization.

Dissonance in the data

Frustration was evident when participants discovered a card in the stack that didn't fit the categories they had established. This was often noted with prepared food cards, i.e., spaghetti which might include vegetables, starches, and meats. Additional items that were hard to categorize included: olives, canned peas (although a vegetable, it wasn't fresh), tofu, almonds (possibly because subjects were looking for additional nuts), and Vienna sausage. Preliminary data suggest almonds were the most difficult to categorize as they were the card most often (8 times) found in a single card pile. Other cards found to be in a single card pile were tofu (4), dip (4), eggs (3) and canned peas (3).

When participants discovered a card that didn't fit the categories they had established, they would shuffle it to the end of the pile, or put it in a separate pile—the undecided pile. Typically these challenging cards were put into a categorized pile at the end.

Another approach to dissonance was revealed by withholding cards. Several individuals, upon coming across a card that did not fit within their existing taxa, would hold the card back until the end and then either force it into a category, or, as one person did, simply discard the card.

Unique orientation toward coding

A participant's sorting was colored by their unique frame of reference. The male who didn't shop sorted everything alphabetically, his mom who shopped and took pre-school children to the grocery store for a field trip, organized items as they are found in the store. The individual trying to eat vegan sorted by vegan/non-vegan, the woman trying to encourage her family to eat healthy used categories such as "whole foods", "meat", "processed meat", and "junk".

Discomfort

A noteworthy finding was some participants (but not all) appeared uncomfortable having a category that contained only one card. For example, a participant might be expecting more types of nuts to emerge as they flip through the pile so they create a 'nuts' category when they reach almonds. However, when the individual realized there were no other nuts, instead of keeping almonds as its own category, other cards were removed from other pre-determined piles to make a new category that would include almonds among other items (for example, a snack pile or a protein pile, etc). Another participant when, getting to the end of the card sort, found two cards that were orphans, stated "I can't have these two just by themselves" and moved the cards into another stack.

Other participants dealt with difficult to categorize cards by creating an "other" pile. The cards in this pile were described as cards that simply didn't fit with their categories. In other words, instead of creating new categories to fit the "weird" cards, they kept their current system and dismissed these cards as "not fitting in."

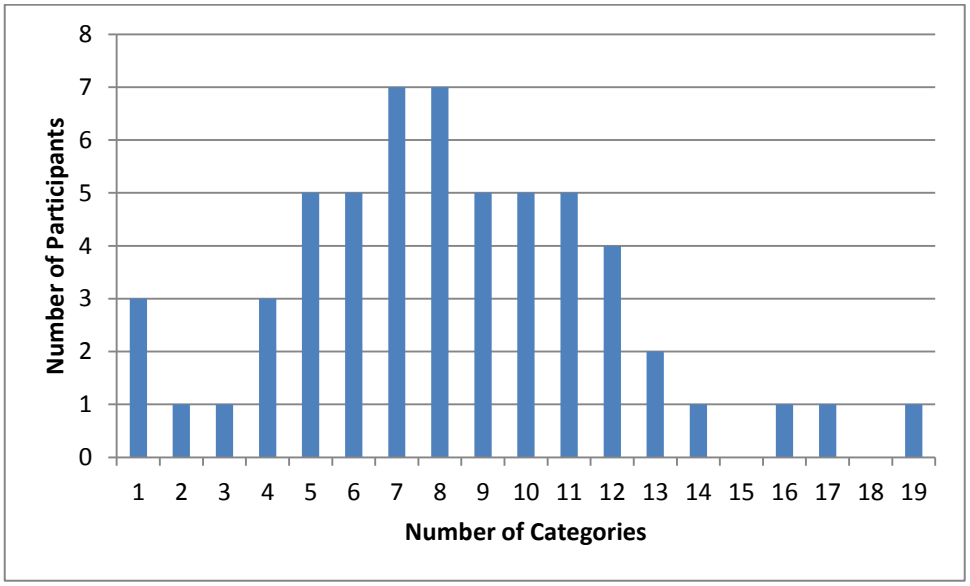
Alteration of initial means of sorting

Generally, people were not likely to change their approach once initiated. This lack of casuistic thinking is not unique to how people make sense of large sets of data, but it *is* amplified and might suggest a reason that individuals have a hard time making sense of complex visualizations. Most people tend to start with the "local" and begin to force items into the established framework. In this case, local would refer to the typical content analysis framework approach of beginning analysis with the first piece of data rather than looking at a block of data before making categorical assignments. Unlike the research approach to content analysis, no individual in the study went back and recoded all cards based on changes in the categories, although a few did pull cards from existing categories to help support a "new" category, even though the card could belong in both categories.

A few individuals, however, did "rethink" their coding strategy and reorganized data. In some cases it was "refining" or splitting larger categories to more accurately distinguish within the categories—for example, one individual started with two categories (would eat/would not eat), then broke each of those into two (like/dislike) and then re-divided cards based on degree of like/dislike.

Visitors sorted the cards into categories based on their own categorization factors, with three visitors either placing all the cards into one pile or creating a continuum. Visitors were most likely to divide the cards into seven or eight categories/piles, with the range of self-created categories varying from two to 19.

Table 1. Participants and Number of Categories



Conclusions and Recommendations

Generally, people are not likely to change their approach once initiated. This lack of casuistic thinking is not unique to how people make sense of large sets of data, but it *is* amplified and might suggest a reason that individuals have a hard time making sense of complex visualizations.

Most people tend to start with the "local" and begin to force items into the established framework. In this case, local would refer to the typical content analysis framework approach of beginning analysis with the first piece of data rather than looking at a block of data before making categorical assignments.

Unlike the research approach to content analysis, no individual in the study went back and recoded all cards based on changes in the categories, although a few did pull cards from existing categories to help support a "new" category, even though the card could belong in both categories.

People seem to be uncomfortable with individual outliers. When single cards did not fit into their categories, people pulled other cards that fit in another category, but could also support the individual card.

Given that most people initiate their categories in the sequence by which the cards are presented, it would suggest that providing dissonance initially in the data would create more critical organizing. One individual who has tofu at the beginning of the pile quickly noted "protein" and then organized based on the nutritional value of the foods.

To apply these findings to a larger audience, it would be prudent to replicate this study in a laboratory setting. Museums are busy places, usually visited with friends or family. If similar findings are noted when the study is replicated in a lab, where participants would not be impacted by family and friends wishing to move to the next exhibit, the findings could then be applied to a larger audience.

Appendix A: Food Choice Cards

Eggs	Cheese Spaghetti	Tomato	Tomato sauce	
Bacon	Crackers	Lasagna	Carrots	Ham sandwich
Bread	Olives	Roast beef	Apples	Bean casserole
Cereal	Chips	Canned peas	Onions	Vegetable soup
Pancake mix	Dip	Hamburger	Banana	French fries
Yogurt	Almonds	Fish	Squash	Tossed salad
Toast	Cake	Shrimp	Eggplant	Pasta sauce
Donuts	Ice cream	Fried chicken	Mango	Frozen meal
Coffee	Soft drink	Milk	Tea	Orange Juice
Sausage	Hot dogs	Tofu	Peaches	Vienna Sausage

Appendix B: Card Sort Ethnogram and Observation Flow Notes

	Observation	**Hesitation/Stop**	**Continue/change**
Initial Approach Second approach Third approach If approach changes, note the change change and begin new set of observation notes	Open notes	Pause with card Pause looking at cards Put aside card Look at two+ cards Shuffle through cards Ask question Engage another person	No change Redo process completely Modify process Blend stacks Divide stacks Shuffle all cards

Initial Approach:

Interview:

(At 4 minutes, if not completed, ask if they wish to continue or feel they're pretty sure of their categories)

Thank you so much for doing this. Could you explain the categories you came up with to me?

I noticed you started by doing _____. Why did you make that decision?

What happened then?

(continue to probe on how the individual arrived at the final organization. Prompts could include "did you begin to question your initial decision? Why? At what point did your organization begin to solidify for you?)

Conclude with a thank you to the individual.