A PROTOTYPE FOR A POPULATION CHOICE EXPERIMENT

1. Introduction

We describe an experiment that allows us to study the properties of population choice probabilities. A population choice probability $P_A(x)$ is the probability that a randomly selected individual from a population, presented with the finite choice set A, chooses object $x \in A$. Random variation of the object chosen from A comes from both variation across individuals and random variation of an individual's choice across repeated presentations of A. A *random choice structure* is the set of all $P_A(x)$ for $x \in A \subseteq T$, where T is a finite master set of choice objects.

We are interested in certain seeing if certain conditions on these probabilities are satisfied or not. For example, we want to know whether a random choice structure satisfies various axioms of probabilistic choice. These axioms include weak, moderate and strong stochastic transitivity, the triangle inequality, regularity, random utility and the multiplicative inequality.

In our experiment, we will use master sets of objects from many different choice domains. See Section 4 for some examples. In all cases, the master set contains five objects.

2. Experimental Design

Our experiment has J domains, each with a master set of size five. There are $I = 2^5 - 5 - 1 = 26$ non-degenerate (i.e. having at least two elements) choice sets for each domain. Each non-degenerate choice set is presented once to a number N of the participants, and there are a total of NI participants. Each participant sees exactly one choice set from each domain, and so faces J trials. Thus there is a total of NIJ trials. At the moment, there are $J = 21$ choice domains outlined in Section 4.

There are several elements of the design to settle. For now, we plan on the following:

(1) $N = 40$, for a total of 1040 participants.
(2) For each domain j, randomly partition the NI participants into I equal groups of N, with each group seeing the same choice set from domain j. Random partitions are statistically independent across domains. (Variation: negative dependence might be useful, to ensure, for example, that each participant sees the same number of doubletons, triples, etc.)
(3) Elements of a choice set are presented in random position (left, middle, right, for example) on the screen, independently across the N participants in the relevant group. (Variation: stratify, so that, for example, half of the N participants see the doubleton $\{a, b\}$ as ab and the other half as ba).
(4) The J trials assigned to each participant are presented in random order, with order independent across participants.

(5) We *may* want domains of size four and three as well.
(6) We *may* want some participants to see two choice sets from a given domain, each the complement of the other. For example, $\{a, b\}$ and $\{c, d, e\}$ from domain $\{a, b, c, d, e\}$.

3. Questions

(1) Can the Institute for Choice conduct such an experiment? Are the various variations on the design, above, feasible?
(2) What would the cost be? Say $NI = 1040$ participant and $J = 21$ trials per participant. Roughly how does the cost depend on the number of participants and the number of trials?
(3) Are there any other constraints (attention, etc.) that effect the number of trials per participant?
(4) What are our obligations concerning ethics approval, as they pertain to the I for C?
(5) Would we have access to and the possibility of modifying code for running the experiment? (For example, if we want to control the randomization of position, partition or order.)
(6) In principle, recruitment of subjects and running the experiment on a server are two different things. Can the I for C arrange both?
(7) In what form would it be most convenient to provide the choice material (text, pictures, tables)?
(8) Is using possibly copyrighted material (pictures, blurbs from films) permissible in an experiment, under the "fair use" doctrine?
(9) Are there any other questions I should be asking, but haven't?

4. Choice domains

We classify choice domains into four categories. In the first category, there are no numerical attributes. In the second category, there is a single attribute, whose level is not explicitly given. In the third category, there are two numerical attributes and the experimental design is intended to elicit one or more context effects. In the fourth category, there are many attributes, and the objects are chosen to resemble objects in discrete choice experiments of the kind conducted at the Institute for Choice.

4.1. **No numerical attributes.**

4.1.1. *Male movie stars.* The source is the IMDb list "Top 25 Biggest MOVIE STARS in the World!" on May 25th, 2015. The choices are the top five male actors in that list, in order.

> Which movie star would you most like to have lunch with?
> (1) Robert Downey Jr.
> (2) Leonardo DiCaprio
> (3) Tom Cruise

(4) Johnny Depp
(5) George Clooney

4.1.2. *Female movie stars.* The source is the IMDb list "Top 25 Biggest MOVIE STARS in the World!" on May 25th, 2015. These are the top five female actors in that list, in order.

Which movie star would you most like to have lunch with?
(1) Meryl Streep
(2) Jennifer Lawrence
(3) Emma Stone
(4) Kristen Stewart
(5) Anne Hathaway

4.1.3. *Film descriptions.* The source is the IMDb list "Most Popular Feature Films Released 1990 to 1999". The decade was chosen so that the films would not be easily recognizable by students.

Judging from the following descriptions of films, which film would you most want to see?
(1) Two imprisoned men bond over a number of years, finding solace and eventual redemption through acts of common decency.
(2) Mathilda, a 12-year-old girl, is reluctantly taken in by Léon, a professional assassin, after her family is murdered. Léon and Mathilda form an unusual relationship, as she becomes his protégé and learns the assassin's trade.
(3) The lives of two mob hit men, a boxer, a gangster's wife, and a pair of diner bandits intertwine in four tales of violence and redemption.
(4) A sexually frustrated suburban father has a mid-life crisis after becoming infatuated with his daughter's best friend.
(5) Identical twins, separated at birth and each raised by one of their biological parents, discover each other for the first time at summer camp and make a plan to bring their wayward parents back together.

4.1.4. *Stars in a film.* The similarity between two choice objects varies, since two pairs of actors have either zero or one actors in common. Thus some pairwise comparisons are easier to make than others, but not in exactly the same way as in a classic similarity effect experimental design. This example may also be interesting because of actor complementarities. The only missing pair from the set of four actors is Brad Pitt and Angelina Jolie. Does it make sense to have a master set of size six, in order to have a complete set? There would be $2^6 - 6 - 1 = 57$ choice sets and therefore choice probability estimates would have about half as much precision.

Knowing only who is starring, which film would you most like to see?
(1) Tom Hanks and Scarlett Johansson
(2) Scarlett Johansson and Brad Pitt
(3) Tom Hanks and Brad Pitt

(4) Scarlett Johansson and Angelina Jolie
(5) Tom Hanks and Angelina Jolie

4.1.5. *Pizza toppings.* The source is the FF Pizza menu at the Beaubien location in Montreal. All these pizzas are either 12 or 13 dollars.

Which of the following pizzas would you prefer?
(1) Mozzarella, tomato sauce, basil
(2) Pepperoni, mushrooms, green pepper, mozzarella, tomato sauce
(3) Red onion, tomato sauce, feta, mozzarella, olive oil, Greek spices, tomato sauce
(4) Bacon, white onion, mozzarella, parmesan, fresh cream, tomato sauce, freshly ground pepper
(5) Mushrooms, green pepper, mozzarella, tomato sauce

4.1.6. *Flavours.*

Which of the following fresh juices would you choose?
(1) Mango
(2) Orange
(3) Apple
(4) Grapefruit
(5) Pineapple

4.1.7. *Colours.*

Which of these colors do you like best?
(1) Red
(2) Purple
(3) Pink
(4) Blue
(5) Green

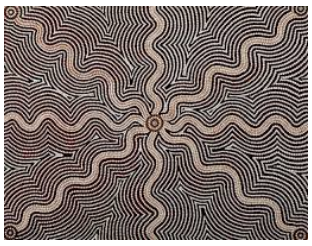
4.1.8. *Color combinations.* The source is the website "The top tens", page "Two colors that look good side by side." The color combinations here are ranked 1, 4, 5, 13 and 14. I chose a selection of high ranking combinations where there were many colors in common.

Which of these colour combinations do you like the best?
(1) Black and red
(2) Black and purple
(3) Black and blue
(4) Blue and red
(5) Blue and purple

4.1.9. *Likelihood of events.* The idea is to see if unions and intersections of events can be used to construct decoys to elicit attraction effects, in cases where probability comparisons are elicited. I want to *avoid* trickiness like "Linda the bank teller" so that unions of events are correctly perceived as more probable than their constituent events and intersections are correctly perceived as less probable. Logically, 5 dominates 1 dominates 4, and 2 dominates 3. I'm worried that the subject matter may not be familiar enough, and that the probabilities in question are too low. It might be a good idea to check out the geopolitical events used in Tetlock's prediction tournaments, to look for more suitable examples.

> Which of the following events is most likely to happen in the next ten years?
>
> (1) Scotland becomes an independent country.
> (2) Either Catalonia or Quebec become independent countries.
> (3) Catalonia becomes an independent country.
> (4) Scotland and Quebec become independent countries.
> (5) Either Scotland or Quebec become independent countries.

4.1.10. *Aesthetic judgements of art.*

> Which of the following examples of Australian Aboriginal art do you find most appealing?
>
> (1) 
> (2) 
> (3) 

(4) 

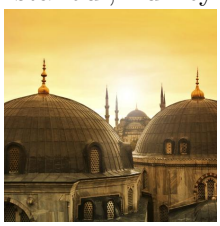
(5) 

4.1.11. *Travel destinations.* The source is Tripadvisor. These are the top five travel destinations, according to some metric. Tripadvisor had a contest in the form of a binary discrete choice experiment, where visitors to their site chose among travel destinations. I can no longer find the contest at the website.

Which of the following travel destinations would you prefer?

(1) Marrakech, Morocco

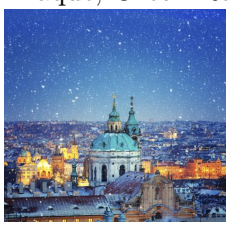
(2) Istanbul, Turkey



(3) Hanoi, Vietnam

(4) Siem Reap, Cambodia

(5) Praque, Czech Republic



4.2. **Single attributes, not directly observed.**

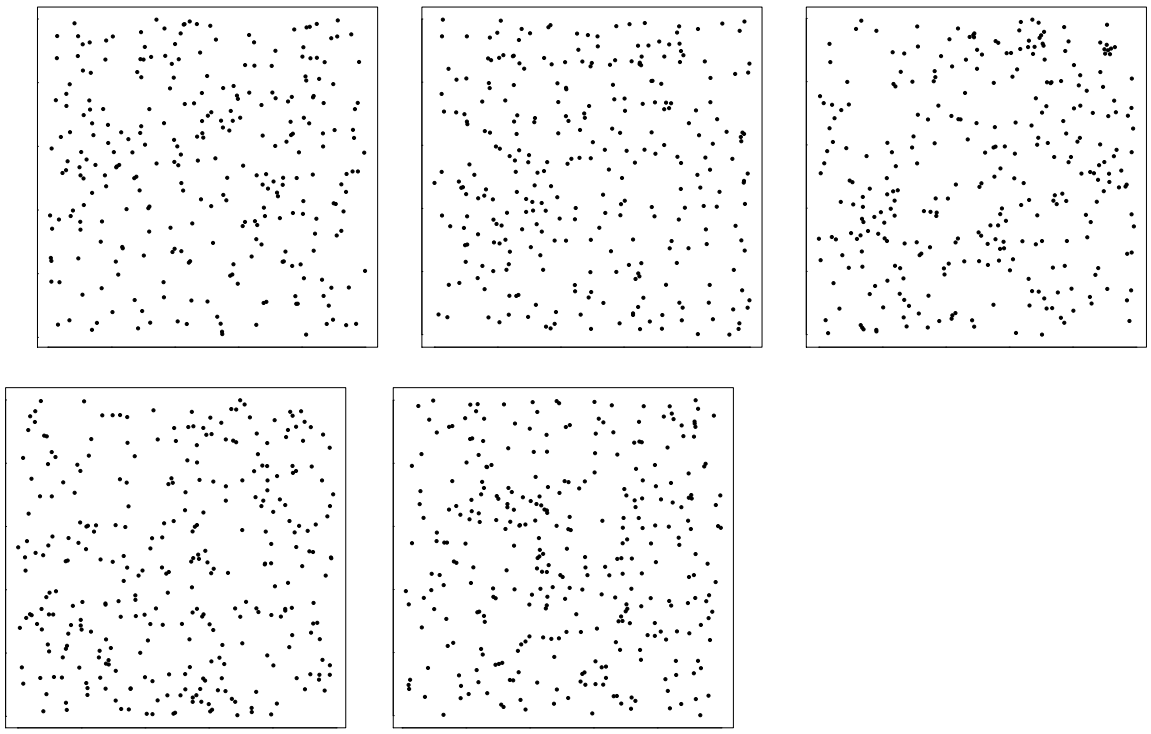
4.2.1. *Judgement of lattitude.* This is an example where there is an objective rank order. All these cities are close to 45 degrees north. Choice is not hedonic, but it is not exactly a perception example, either.

Which of the following cities do you think is furthest north?

(1) Toronto, Canada
(2) Minneapolis, United States
(3) Geneva, Switzerland
(4) Bucharest, Romania
(5) Lyon, France

4.2.2. *Perception of number of points.* This is a perception example and there is an objective right answer.

Which of the following boxes has the greatest number of points?



4.2.3. *Country populations.* These countries are ranked 4th through 8th in terms of population.

Which of the following countries do you think has the biggest population?
(1) Indonesia
(2) Brazil
(3) Pakistan
(4) Nigeria
(5) Bangladesh

4.2.4. *Country surface areas.* These countries are ranked 2nd through 6th in terms of surface area

Which of the following countries do you think has the greatest surface area?
(1) Canada
(2) United States of America
(3) China
(4) Brazil
(5) Australia

4.3. **Objects with two attributes.** These are used to capture two-attribute context effects. See the various context effect (CE) designs in the Appendix.

4.3.1. *Beer.* This example is from Huber et al. (1982). The prices are multiplied by 5 and choice objects 4 and 5 were added by me, to get an example of CE design 1, described in Appendix A. The most commonly used domains to illustrate the attraction effect are Beer, Cars, Apartments, Computers, Restaurants and Televisions.

> Below you will find three brands of beer. You know only the price per sixpack and the average quality ratings made by subjects in a blind taste test. Given that you had to choose one brand to buy on this information alone, which one would it be?

Brand	Price/sixpack	Average quality rating (100 = Best; 0 = Worst)
1	\$9.00	50
2	\$13.00	70
3	\$15.00	70
4	\$14.00	75
5	\$15.00	80

4.3.2. *Flights.* This is an example of CE design 4.

> Which of the following flight itineraries would you choose? All involve two flights.

Itinerary	Total flight time	Layover time
1	4:00	1:00
2	3:24	1:48
3	3:15	2:00
4	3:06	2:12
5	2:30	3:00

4.3.3. *Cars.* This is based on an experiment from Wedell and Pettibone (1996). Objects 1 and 2 are from their experiment. I added objects 3, 4 and 5 to these two to obtain an example of CE design 2.

> Which of the following cars would you prefer to drive, all other features begin equal? Ride quality is a on a scale of 0 to 100.

Car	Ride quality	Miles per gallon
1	60	30
2	80	24
3	70	27
4	55	28
5	75	22

4.3.4. *Restaurants.* This is an example of CE design 3. Many studies have looked and restaurants, some with similar attributes.

> Which restaurant would you most like to go to for your next restaurant meal, based on transportation time (in minutes) and average customer ratings (from 1 to 5).

Restaurant	Transportation time	Rating
1	34	4.4
2	22	4.0
3	19	3.9
4	7	3.5
5	22	3.9

4.4. **Objects with multiple attributes.**

4.4.1. *Flight and layover durations.* This illustrates three-way tradeoffs. The points form a constellation in the simplex that is a bit like on the "five" side of a die.

> Which of the following flight itineraries would you choose? All involve two flights and have a total duration of six hours.

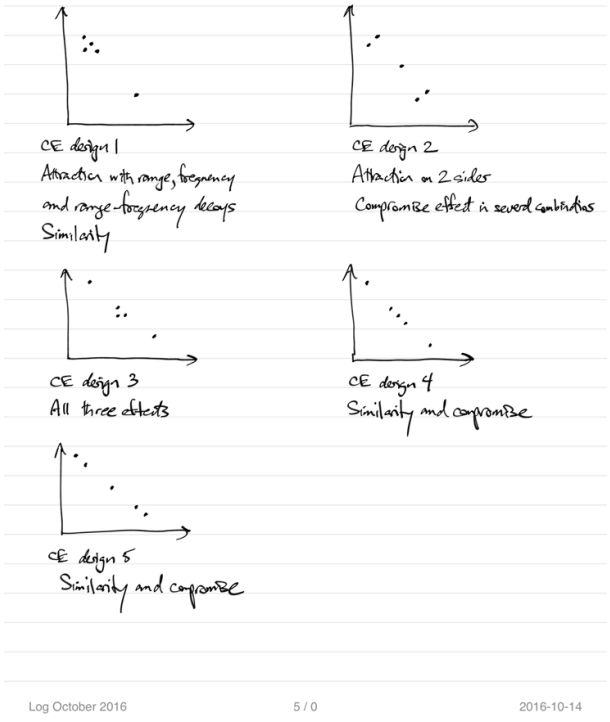
Itinerary	1st flight	Layover	2nd flight
A	1:30	1:15	3:15
B	3:15	1:15	1:30
C	2:15	1:30	2:15
D	1:30	1:45	2:45
E	2:45	1:45	1:30

4.4.2. *Televisions.* These televisions were available at Best Buy Canada.

> Which of the following televisions would you be most likely to buy if you were in the market for a television? All are LED televisions. Resolution refers to number of horizontal lines. Smart indicates internet connectivity.

Brand	Resolution	Smart	Price ($)	Screen Size (inches)
Sharp	1080	Yes	309	32
Insignia	720	No	209	32
Sony	720	Yes	439	32
Samsung	1080	Yes	459	40
Toshiba	1080	No	409	43

FIGURE 1. Five context effect designs, each with a domain of five different objects. In each case there are two attributes, corresponding to the horizontal and vertical axes.



APPENDIX A. CONTEXT EFFECT DESIGNS

Figure 1 illustrates graphically five different context designs, each with five different objects.