The Temporal Component of Reference Point Determination

Abstract

The idea of reference dependence, that consumers (and more generally, people) fix a quantitative point of reference either explicitly or implicitly which both influences their choices and the utility derived from these choices, is an integral part of the relatively new field of Psychology and Economics. Previous studies have concluded that reference-dependent preferences play a substantial role in determining at which price levels consumers are willing to purchase a given product. Although several theories have been advanced concerning how consumers establish these reference points, with the most commonly held view being recent expectations, few studies have been done regarding the length of *time* necessary to fix or modify a reference point. However, the temporal component of reference point determination is also significant, for knowing how long it takes for consumers to adjust is clearly an influential part of truly understanding consumer behavior. In this paper I develop and conduct an experiment to observe the duration of time required to establish a reference point, analyze implications of the resulting data, highlight potential applications of this research to relevant policy issues, and suggest possible directions for further research on the topic.

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Undergraduate Honors Thesis
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May 2, 2011

1 Introduction

As correctly evaluating outcomes based on an absolute scale often proves to be difficult, we, as humans with advanced cognitive abilities, frequently determine their values by comparing them with other outcomes that serve as reference points. The defining characteristic of reference dependence is the importance of relativity in decision-making, i.e., outcomes are not solely evaluated for the utility derived from them, but the comparison of the utility derived from that event and another. For example, if someone was promised an expensive car and then given a bicycle instead, they would likely be more disappointed than if a bicycle was given to someone without any previous promise of a car.

The initial model regarding the behavior of individuals under uncertainty was Daniel Bernoulli's *Expected Utility Theory* in 1738. In the next section I will cover the assumptions of this model that have proved to be questionable when examined by economists studying Psychology and Economics. Kahneman and Tversky attempted to resolve these issues by proposing a different model in 1979 called *Prospect Theory,* which first proposed reference dependence. As to what determines the reference point, there have been several suggestions, including status quo or social comparisons. However, the most recent and commonly held explanation is based on expectations, as proposed by Botond Köszegi and Matthew Rabin in their 2006 paper *A Model of Reference-Dependent Preferences.*

Despite the many studies and advances in this area, there is a nontrivial component of the reference-dependent preferences model that unfortunately remains unsolved: the length of *time* necessary to establish or change a reference point. Examining how long it takes for people to fix an initial point of reference, or to change an existing point of reference, could provide substantial understanding regarding how consumers respond to changes in prices. For example, if a

consumer's reference point for a particular digital camera is $200 (because it has sold at this price in the past and the consumer does not expect a change) and it then goes on sale for $150, the consumer will see this price as a relative gain. But if the sale lasts for too long, this consumer might adapt her reference point to the new sale price, causing her reference point to now be fixed at $150, meaning that $150 will no longer feel like a relative gain to her, and the price of the camera might need to be decreased even further to induce her to buy it. Similarly, if the seller decides to raise the price back up to $200, the consumer will perceive buying at that price as a relative loss, and her loss aversion will likely prevent her from purchasing the camera even though that was previously her reference point. The unresolved issue is how *long* it takes for the sale price to become her new reference point. Improved understanding of this topic would not only assist in the realm of consumer behavior, but in macroeconomic policy applications, such as the behavior of job seekers. Because reference points are not an inherent benchmark or a stagnant level, but rather something that is formed by an individual and subject to change, it is inadequate to ignore how time affects these relations.

In this paper I propose and execute an experiment specifically designed to investigate the effects varying durations of time have on the adjustment of reference points. I carried out this experiment in all the discussion sections of an undergraduate economics course (Economics 100A – Intermediate Micro Theory) at UC Berkeley. The students were either given a $1 or $5 discount on the product via a random draw, and were aware that 50% of the class received each discount. They were then asked to complete a survey, which implemented the Becker-DeGroot-Marschak method, by circling "buy" or "don't buy" at a series of prices. Although it would be interesting and potentially worthwhile to vary the time widely among different groups, limited resources allowed me to only expose subjects to one of three time durations: 0 minutes, 30

minutes, or 48 hours. For one-third of the sections, students completed the survey immediately after receiving the discount information. For another third of the sections, students completed the survey approximately half an hour after receiving the discount information. For the last third of sections, students completed the survey 48 hours after receiving the discount information. Despite the difficulties in conducting an experiment outside of a social science laboratory, I was able to gather data for 142 subjects.

My hypothesis is that time will influence the subjects' willingness-to-pay through the effect it has on the establishment and modification of reference points. In this study I am not focusing on the quantitative size of the discount received, but rather the psychological impact it had on the subject and their reported willingness-to-pay. I believe that the sense of disappointment felt by receiving the $1 discount while simultaneously knowing that half of one's peers received a better deal, the $5 discount, will initially be more palpable and will manifest itself by reducing the individual's willingness-to-pay. However, I believe that over the course of time this initially unattractive outcome (a loss relative to the individual's classmates) will become the individual's reference point, and will play less of a role in the purchasing decision. Conversely, I believe that the initial sense of satisfaction acquired from receiving the $5 discount (a gain relative to the individual's classmates) will temporarily inflate the individual's willingness-to-pay for the product, and that as the reference point is modified over time to absorb the new discount information, the effect on willingness-to-pay will diminish. The longer the hiatus between receiving the information and making the purchasing decision, the more time the consumer has to adjust his or her reference point. Essentially, this amounts to an initial divergence, and eventual convergence, of willingness-to-pay for the product between the $1 and $5 discount groups.

Figure 1: *Source: Kahneman 2002*.

In this experiment I hope to acquire data that demonstrates the relationship between the passage of time and adjustment of one's reference point through purchasing decisions. I will then present data and descriptive statistics from this experiment and an analysis using econometric models, looking for possible statistical significance in the observed results. Finally, I suggest possible conclusions about the timing of reference point adjustments that could be feasibly derived based on the experimental outcomes, acknowledge potential complications and shortcomings, consider some implications for current policy issues, and make recommendations regarding further research.

2 Literature Review

The Psychology of Reference dependence

I will begin by examining the psychology upon which the concept of reference dependence is formulated. “When we respond to attributes such as brightness, loudness, or temperature, the past and present context of experience defines an adaptation level, or reference point, and stimuli are perceived in relation to this reference point” (Kahneman and Tversky 1979). Figure 1 demonstrates the innate human tendency to form comparisons: upon viewing the two squares we

automatically compare the shade of the inner square to that of the outer square. This illustrates the idea of reference dependence, as "an account of perceived brightness also requires a parameter for a reference value (often called adaptation level), which is influenced by the luminance of neighboring areas" (Kahneman 2002). Despite the fact that the two inner squares are the exact same shade of grey, the inner square on the right appears much darker because we are using cognitive comparisons to evaluate the shade of the inner square by comparing it to the lighter outer square – it is darker than the neighboring area, and we thus views it as "dark," whereas the square lighter than its neighboring area is viewed as "light." Using relativity in evaluating outcomes applies not only to these types of corporal reactions, but also to economic decision-making, such as evaluating utility in a risky situation or the decision to purchase a particular good.

The Model

Kahneman and Tversky's *Prospect Theory* model of 1979 suggested that Bernoulli's *Expected Utility Theory* of 1738 was not compatible with reference dependence, as it evaluated outcomes solely on an absolute scale and ignored the use of relativity in assigning values to outcomes. The definition of reference dependence that their model provides is that "the value function v is defined over differences from a reference point r, instead of over the overall wealth" (Kahneman and Tversky 1979). Although there are other characteristics that are unique to *Prospect Theory,* such as overweighting small probabilities, which further distinguish it from *Expected Utility Theory*, the model "is rarely applied in its entirety, often appealing just to reference dependence and loss aversion" (Dellavigna 2009) – a practical simplification that will also be applied in this paper.

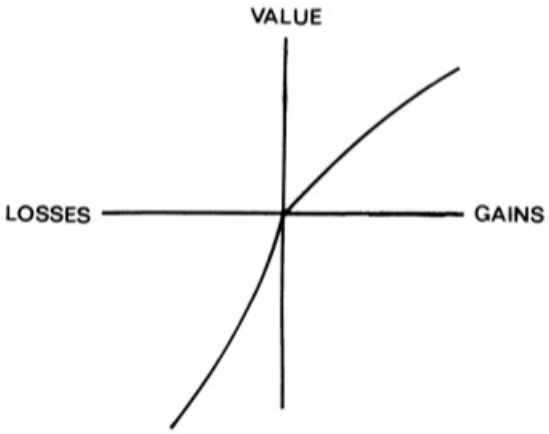

Figure 2: *Source: Kahneman 2002.*

The value function pictured above in Figure 2 illustrates the model of reference-dependent valuation proposed by Kahneman and Tversky's *Prospect Theory*. The kink at the origin represents the reference point; deviations to the right of the reference point are viewed as gains, and deviations to the left are viewed as losses. "In these models, individuals compare outcomes to their expectation and dislike an outcome falling short of expectations" (Abeler et al. 2011). This value function demonstrates that consumers possess a degree of *loss aversion* (i.e., the disutility derived from a loss relative to the reference point is greater than the utility derived from a same-sized gain) – which is reflected by the steeper slope in the loss domain compared to the relatively flatter slope in the domain of gains. Additionally, the concavity in the domain of gains and convexity in the domain of losses reflects *diminishing sensitivity* – i.e. the further away from the reference point, the less palpable the marginal effect on utility from additional gains or losses. "As with loss aversion, Kahneman and Tversky (1979) argue that diminishing sensitivity reflects a more fundamental feature of human cognition and motivation" (Rabin 1996).

Knowing how people modify their reference points is important because "shifts of reference can change the value difference between outcomes and thereby reverse the preference

order between options" (Kahneman and Tversky 1981). Köszegi and Rabin propose that overall utility of a particular consumption bundle, given the reference point, is

$$u(c|r) = m(c) + n(c|r)$$

where c is the consumption bundle, r is the reference point, "m(c) is consumption utility typically stressed in economics, and n(c|r) is "gain-loss utility" (Köszegi et Rabin, 2006). Further separation of the components of the utility function leads to

$$m(c) = \sum_{k} m_k(c_k)$$

$$n(c|r) = \sum_{k} n_k(c_k|r_k)$$

In the above equations, each value of k represents a different good or service in the consumption bundle. Köszegi and Rabin go even further: "Because the sensation of gain or loss due to a departure from the reference point seems closely related to the consumption value attached to the goods in question, we assume that

$$n_k(c_k|r_k) = \mu(m_k(c_k) - m_k(r_k))$$

"where $\mu(\cdot)$ satisfies the properties of Kahneman and Tversky's (1979) value function" (Köszegi et Rabin, 2006).[1] That is, reference-dependent utility is a function of the difference between consumption utility at the reference point and consumption utility at the actual value.

Determination of Reference Points

Now that the idea of reference dependence has been proposed and the model introduced, another issue arises for consideration and research: *how* reference points (the "r" in the above

[1] See: Köszegi, Botond, and Matthew Rabin. "A Model of Reference-Dependent Preferences" for further mathematical equations and proofs pertaining to this model.

model) are established, determined, or modified. Some theories regarding what determines a reference point are status quo (Kahneman and Tversky 1979), social comparisons (Neumark and Postlewaite 1998), goals (Heath et al. 1999), and expectations (Köszegi & Rabin 2006).[2] The status quo was held as the most likely candidate until Köszegi and Rabin realized that "although existing evidence is instead generally interpreted by equating the reference point with the status quo, virtually all of this evidence comes from contexts where people plausibly *expect* to maintain the status quo" (Köszegi and Rabin 2006). However, the status quo and expectations are not necessarily equivalent in every situation. They found the principal determinant of reference points to be expectations rather than the status quo. A manifestation of the model that is especially pertinent to this paper is the *comparison effect*, which proposes "a decrease in the price a consumer expected to pay makes paying a higher price feel like more of a loss [and] lowers her willingness to pay the high price. Hence, the lower the prices she expected among those prices that induce purchase, the lower is her willingness to buy at higher prices" (Köszegi and Rabin 2006). Because this model acknowledges that the reference level "r" is subject to change, I believe it would benefit from further research on how quickly consumers shift their reference points.

3 Experimental Design

Procedure

See attachment: *Visualizing the Experimental Procedure*.

The study employed a between-subjects experimental design and was conducted on paper using student participants from an intermediate microeconomics course at UC Berkeley. The

[2] See also: Bell 1985, Loomes & Sugden 1986, Gul 1991, Shalev 2000, and Köszegi and Rabin 2007.

independent/explanatory variable in this study is the amount of time that passed between receiving the discount information and completing the survey. For 5/13 of the discussion sections, henceforth referred to as "Group A," the purchasing decisions were made immediately following the distribution of the discount information (whether the subject received the $1 discount or the $5 discount). For 4/13 of the discussion sections, henceforth referred to as "Group B," the discount information was provided at the beginning of the discussion section, and purchasing decisions were made at the end of the section following their normal lesson with their Graduate Student Instructor. This amounted to approximately thirty minutes between additional discount information and survey completion. For the final four remaining sections, henceforth referred to as "Group C," discount information was given on the first discussion of the week, and the surveys were completed 48 hours later on the next section meeting.

The discount information was assigned via random draw. The seat numbers were then divided into two groups, and a random draw was done to determine which group would receive the $1 and $5 discounts. Transparency in the random draw process was particularly emphasized. The subjects were told at the beginning of the experiment that only 10% of them would receive the show up fee via random draw. I carefully explained to the subjects that this determination would be the very last step, so subjects should act under the assumption that they could be part of that 10%. Taking into account their discount, which I explained to them as essentially a coupon on the product, they completed a paper survey which presented a brief description of the product and employed the Becker-DeGroot-Marschak method. (Figure 3 presents the survey.) Samples of the product were passed around the room so that each participant had ample time to examine the item. The students decided at each price level (between $1 and $25, in increments of $0.50) whether they would choose "buy," i.e. purchase the product at that price, or "don't buy",

Seat number: ____

Skullcandy INK'd Earbuds with In-Line Microphone

- 11 millimeter drivers with neodymium magnets for full-range sound
- Two sizes of silicone gel earbud sleeves for a perfect fit
- Mic with Control switch: In-line (on cord) mic, plus iPod Play // Pause // Track Control, 1.3-meter nylon braided cable with gold-plated 3.5mm plug
- In-ear design allows for passive noise isolation
- Frequency response: 20-20K Hz

Please complete the following. For each price, please indicate using complete honesty whether or not you would buy the product at that price, by circling either "buy" or "don't buy." If you are part of the 10% that receives the money, and you have circled "buy" at the price that is selected, you will be forced to follow through with the purchase. The show-up fee will be sufficient to cover the cost of the product, so that no one is forced to pay out of pocket for the purchase. Keep in mind: the price listed would be the price after discount.

Price of Product	Buy or Don't Buy	
$1.00	Buy	Don't Buy
$1.50	Buy	Don't Buy
$2.00	Buy	Don't Buy
$2.50	Buy	Don't Buy
$3.00	Buy	Don't Buy
$3.50	Buy	Don't Buy
$4.00	Buy	Don't Buy
$4.50	Buy	Don't Buy
$5.00	Buy	Don't Buy
$5.50	Buy	Don't Buy
$6.00	Buy	Don't Buy
$6.50	Buy	Don't Buy
$7.00	Buy	Don't Buy
$7.50	Buy	Don't Buy
$8.00	Buy	Don't Buy
$8.50	Buy	Don't Buy
$9.00	Buy	Don't Buy
$9.50	Buy	Don't Buy
$10.00	Buy	Don't Buy
$10.50	Buy	Don't Buy
$11.00	Buy	Don't Buy
$11.50	Buy	Don't Buy
$12.00	Buy	Don't Buy
$12.50	Buy	Don't Buy
$13.00	Buy	Don't Buy
$13.50	Buy	Don't Buy
$14.00	Buy	Don't Buy
$14.50	Buy	Don't Buy
$15.00	Buy	Don't Buy
$15.50	Buy	Don't Buy
$16.00	Buy	Don't Buy
$16.50	Buy	Don't Buy
$17.00	Buy	Don't Buy
$17.50	Buy	Don't Buy
$18.00	Buy	Don't Buy
$18.50	Buy	Don't Buy
$19.00	Buy	Don't Buy
$19.50	Buy	Don't Buy
$20.00	Buy	Don't Buy
$20.50	Buy	Don't Buy
$21.00	Buy	Don't Buy
$21.50	Buy	Don't Buy
$22.00	Buy	Don't Buy
$22.50	Buy	Don't Buy
$23.00	Buy	Don't Buy
$23.50	Buy	Don't Buy
$24.00	Buy	Don't Buy
$24.50	Buy	Don't Buy
$25.00	Buy	Don't Buy

Figure 3: Willigness-to-pay survey completed by participants.

i.e. accept that amount in cash instead. By finding the highest price which induced purchase for the participant, this procedure effectively determined the subject's willingness-to-pay for the item. There were two necessary conditions for a purchase of the item to take place: the student must have 1) received the show up fee, and 2) indicated on their survey that they wished to purchase the product at the price that I selected. This was so that no student was forced to pay out of pocket for the product, but that real stakes still existed and students were held to their purchasing decisions. For the participants who were chosen to actually receive the show up fee or the product, I decided ahead of time that I would check their surveys at $10 to see the choice subjects made at that price. Then depending on whether they chose "buy" or "don't buy," I provided the participant with either the earphones or $10 in cash. All participants (both those who received the $1 discount and those who received the $5 discount) ended up facing the same price, i.e. the discount they received did *not* actually affect what the subjects paid. This was done so that 1) the results from the surveys would be easier to compare, since they both were the prices *after* discount, and 2) I would not have to distribute different show up fees or "charge" different amounts for the product. The fact that the discount did not actually affect the price of the product is not a violation of the *no deception* tenet of economics experiments. Rather it can be justified by considering that the $1 and $5 discount groups simply faced two different prices in the market (i.e. they were making their purchasing decisions at two different stores that priced the product differently). I explained extremely carefully to the subjects that the prices listed on the survey should be thought of as the price *after* discount, i.e. the price that they would be charged after they used their coupon. I made sure that all participants were clear that if, for example, they were part of the $5 discount group and they circled that they would "buy" at $5

Figure 4: Item used for valuation.

that meant they faced an initial (pre-discount) retail price of $10. Participants were aware that regardless of the highest price they circled, the show up fee would be sufficient to cover the price of the product.

Choice of Product

The item chosen for valuation was a pair of "Skullcandy INK'd Earbuds with In-Line Microphone" (see Figure 4 above). The product was carefully selected, particularly with respect to ensuring the broadest possible desirability (desirable regardless of gender, for example). Another important consideration was avoiding the possibility that subjects who already owned a similar item would simply disregard the survey. An important aspect of earphones was their tendency to break often, which meant that purchasing a backup or replacement pair would still be a good idea. The retail price was not disclosed to participants, for "beyond the fact that price can

signal quality, it can also signal market conditions. Price can inform consumers about search costs, such as competitors' prices elsewhere, or prices in the future" (Jahedi 2010).[3]

Surveying Technique

In order for each subject to determine his or her valuations, the surveys employ the Becker-Degroot-Marschak method. At each given price, the participant must choose one of two options: either *buy* or *don't buy*. By examining the highest price at which *buy* is circled, each theoretical consumer's willingness-to-pay can be determined. There are dual benefits of employing the BDM method, rather than directly asking, "How much would you be willing to pay for this item?" First, the method is incentive-compatible because subjects are unable to influence the price of the product through their response, so it is clearly in their best interest to honestly report their preferences. Secondly, and rather intuitively, by being presented with each price and having to make an active decision between buying and not buying, subjects are likely to choose more carefully instead of quickly filling in the blank and finishing the survey.

A useful step that I chose to undergo was the informal distribution of the survey to a group of my peers beforehand. This was done to get a rough idea of the range of values people assign to narrow down the numbers to put on the valuation tables, as an unnecessarily high upper pricing bound on the survey could influence the participants' beliefs about how much the product's actual value. "For example a high price cue might signal that the consumer's initial belief about the prices in the marketplace was too low" (Jahedi 2010). Thus the table was narrowed down to the range of $1 to $25, in $0.50 increments.

[3] Only necessary information and directions were shared with the participants during the experiment. However, they were allowed to learn the retail price when they were "debriefed" via a Powerpoint Presentation the week following the experiment (see attachment).

Considerations

There are several practices traditionally employed in economics experiments that were relevant to this study. One of these aspects is *no deception*: that participants in the study were not deceived or tricked into believing something other than the truth, although it is not necessarily required that the full purpose of the experiment be disclosed to them. Another convention is that participants received some sort of compensation for their cooperation, so there is an incentive to participate fully and disclose the truth. In this experiment, only 10% of students received the show up fee or product, although it amounted to a slightly higher percent (for example, a class of twelve had two students receive the show up fee). Because limited funding was present, this method of compensation allowed for a greater number of subject participants than a compensation plan which granted all subjects their show up fee. Subjects were aware that for approximately 10% of the class their purchasing decisions recorded on the surveys would translate into real choices between the product and the money, thus allowing this experiment to still adhere to the tenet of *real stakes* in economics experiments.

Randomization

Several occurrences of randomization and "random draw" practices were present in this experiment. First of all, each discussion section belonged to one of three groups: Group A, Group B, or Group C. Although there were scheduling restraints that mandated particular sections belong to certain groups (for example, there were two Monday Wednesday 9:00-10:00 sections, so one section had to be visited each of the two days, which excluded them from being part of Group C which required two visits to the same section), the different groups visited on each day of the experiment were partially randomized. This was meant to control for 1) the

different subject characteristics of students in different discussion sections (for example, one might imagine that students who selected an 8:00 a.m. discussion section differ from those who selected a 4:00 p.m. section), and 2) the fact that by the last day I might have improved my ability to clearly explain the procedure to the students.

Additional randomization occurred in the form of "random draws." The first random draw pertained to the assignment of half the class to the $1 discount group, and the other half of the class to the $5 discount group. The second random draw occurred at the last step of the experiment, to determine which of the students would be selected to receive either the product or the cash show up fee, depending on their reported preference from the survey. Numbers that corresponded to the students' seat numbers were randomly drawn from a bag. I tried to make these processes as transparent as possible to encourage subjects' confidence in the experiment.

Anonymity

Referring to the subjects by seat number rather than name protected subject privacy. At the beginning of the experiment subjects received seat numbers, and were referred to only by their seat number for the duration of the experiment, in the interest of anonymity.[4] The subjects were required to record only their seat number on their surveys and did not need to provide any other identifying information. These seat numbers served another purpose as a method of assigning half the class to one discount group and half the class to the other discount group, as I was able to assign N/2 subjects to each discount group.

[4] This being with the exception that Group C participants, who were required to attend on two separate days, filled out a seating chart on the first day where they wrote their name next to their seat number. This was done in case someone had forgotten his or her seat number by the second day. This practice did not compromise anonymity, as the student would be the only one to reference the seating chart, and only in the instance that they could not remember their seat number (although they generally did very well at remembering both their seat number and their discount).

Difficulties

Because this experiment was carried out in a classroom setting rather than in a controlled social science laboratory, a few logistical issues presented themselves. For one, because the experiment spanned five days, with different sections visited on each day, there is always the possibility that students conversed with friends in other sections and potentially imparted influential information upon them. To attempt to mitigate the adverse effects this would cause, participants were repeatedly, and strongly, encouraged to not speak to their peers about the experiment until its conclusion. Another obstacle occurred in the sections that required attendance on two separate days in order to participate. Because the critical information was given on the first day, but the surveys were not distributed until the second day, those subjects who failed to show up to either of the two sections were not included in the data. Additionally, the very act of getting the subjects to show up to section proved to be problematic. Because participants in controlled laboratory experiments are taken from a pool of people who purposely volunteered to join a subject pool, whereas these subjects were chosen based solely on their enrollment in the selected course, it is not surprising that N = 142 even though 293 enrolled students could potentially have participated. Of course, there is also simultaneously a benefit to having a subject pool *not* based on volunteerism, as it theoretically yields a less self-selecting subject pool. Furthermore, because Group C subjects spent 48 hours away from the testing site, I worried that participants could go home and research how much these specific earphones cost online. To control for the possibility of encountering additional and potentially confounding pricing information in the interim, on the first day the earphones were only mentioned briefly (without mention of brand or model) and were only seen by the students from a sufficient distance to make identifying the exact model difficult.

Table 1: **Number of Subjects by Discount Group and Temporal Treatment Group**.

	Group A	**Group B**	**Group C**	**Total N for discount group**
$1 Discount	28	20	22	70
$5 Discount	29	20	23	72
Total N for treatment group	57	40	45	***Overall N =142***

4 Results

The total number of students who participated in the experiment was 144, although two surveys from the first section had to be excluded because the students did not record their seat numbers, thus rendering them unusable. Overall, there were 70 participants who received the $1 discount and 72 who received the $5 discount, which was extremely close to the ideal distribution of 50% in each of the two discount groups (see Table 1). Furthermore, in the $1 discount group 28 of the 70 subjects were part of Group A (0 minutes between information acquisition and purchasing decision, or no temporal treatment), 20 in Group B (30 minutes), and 22 were part of Group C (48 hours). In the $5 discount group 29 of the 72 subjects were part of Group A, 20 belonged to Group B, and 23 belonged to Group C.[5]

There was clearly wide variation in the participants' valuations for the product, as responses ranged from not willing to buy the product at any price, to willing to purchase the product for $25. For those who received the $1 discount, the mean willingness-to-pay for Group A subjects was $6.75, $7.18 for Group B subjects, and $7.75 for Group C subjects. Among the participants who received the $5 discount, the mean willingness-to-pay for Group A was $7.60,

[5] It makes sense that Group A had more subjects in both the $1 discount and $5 discount groups as this group included 5/13 discussion sections, whereas Group B and Group C each included 4/13 of the discussion sections.

Table 2: **Summary Statistics for $1 Discount Group WTP Responses**.

Alpha value (for confidence interval)	0.05		
	WTP for $1 Discount Group		
Count	70	*Skewness*	0.41717
Mean	7.18571	*Skewness Standard Error*	0.28262
Mean LCL	6.23537	*Kurtosis*	2.7964
Mean UCL	8.13606	*Kurtosis Standard Error*	0.54188
Variance	15.8853	*Alternative Skewness (Fisher's)*	0.42636
Standard Deviation	3.98564	*Alternative Kurtosis (Fisher's)*	-0.12806
Mean Standard Error	0.47637	*Coefficient of Variation*	0.55466
Minimum	0.E+0	*Mean Deviation*	3.2302
Maximum	18.	*Second Moment*	15.65837
Range	18.	*Third Moment*	25.84822
Sum	503.	*Fourth Moment*	685.63374
Sum Standard Error	33.34623	*Median*	7.
Total Sum Squares	4,710.5	*Median Error*	0.07136
Adjusted Sum Squares	1,096.08571	*Percentile 25% (Q1)*	4.75
Geometric Mean	5.96359	*Percentile 75% (Q2)*	10.
Harmonic Mean	5.1654	*IQR*	5.25
Mode	5.	*MAD*	2.75

Table 3: **Summary Statistics for $5 Discount Group WTP Responses**.

	WTP for $5 Discount Group		
Count	72	*Skewness*	0.99663
Mean	7.09722	*Skewness Standard Error*	0.27894
Mean LCL	5.93616	*Kurtosis*	4.57015
Mean UCL	8.25829	*Kurtosis Standard Error*	0.53544
Variance	24.41295	*Alternative Skewness (Fisher's)*	1.01796
Standard Deviation	4.94095	*Alternative Kurtosis (Fisher's)*	1.7731
Mean Standard Error	0.5823	*Coefficient of Variation*	0.69618
Minimum	0.E+0	*Mean Deviation*	3.7662
Maximum	25.	*Second Moment*	24.07388
Range	25.	*Third Moment*	117.72059
Sum	511.	*Fourth Moment*	2,648.63563
Sum Standard Error	41.92532	*Median*	6.75
Total Sum Squares	5,360.	*Median Error*	0.08601
Adjusted Sum Squares	1,733.31944	*Percentile 25% (Q1)*	4.5
Geometric Mean	5.48523	*Percentile 75% (Q2)*	10.
Harmonic Mean	5.44414	*IQR*	5.5
Mode	10.	*MAD*	3.25

Table 4: **Comparison of WTP Results From Both Discount Groups**. The only relationship that visibly stands out in this chart is the initial appearance that for the $1 discount group, the longer time spent with the new pricing information led to a slightly increased willingness-to-pay for the item.

	$1 Discount	$5 Discount
n (number of subjects)	70	72
Min WTP	$0	$0
Max WTP	$18	$25
Mean WTP for Group A (t=0 minutes)	$6.75	$7.60
Mean WTP for Group B (t=30 minutes)	$7.18	$6.25
Mean WTP for Group C (t=48 hours)	$7.75	$7.20
Overall Mean WTP	$7.19	$7.10

$6.25 for Group B, and $7.20 for Group C. Overall, the mean willingness-to-pay for those who received the $1 discount was $7.19 and $7.10 for those who received the $5 discount. (See summary statistics for the $1 and $5 discount groups as presented above in Tables 2-4.)

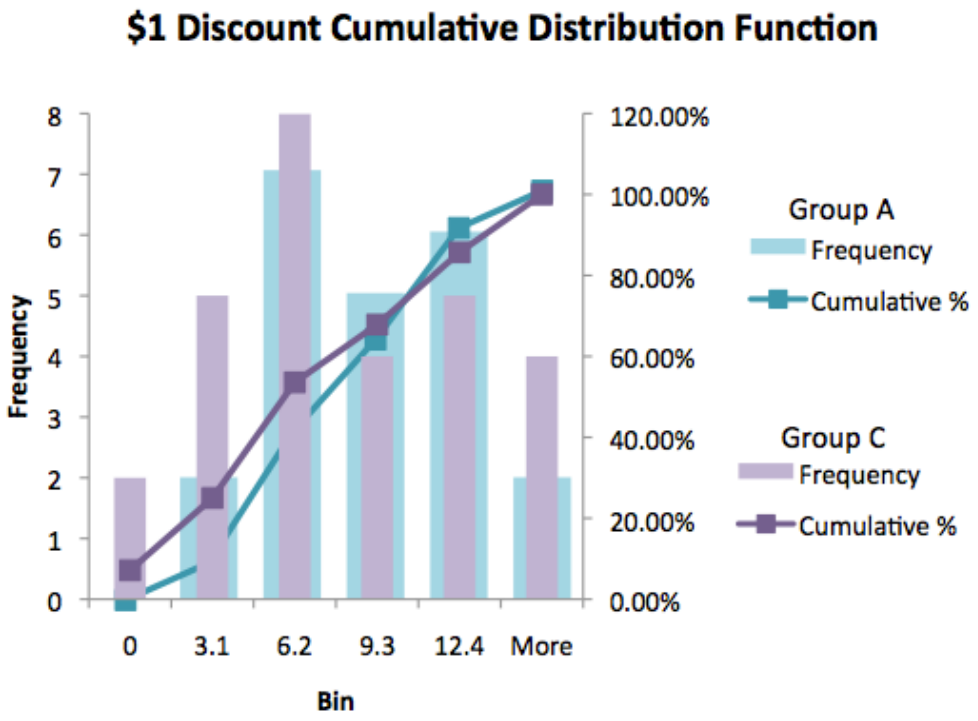

Figure 5: Cumulative Distribution Function for the $1 Discount WTP. Group A is represented by the blue and Group C is represented by the purple.

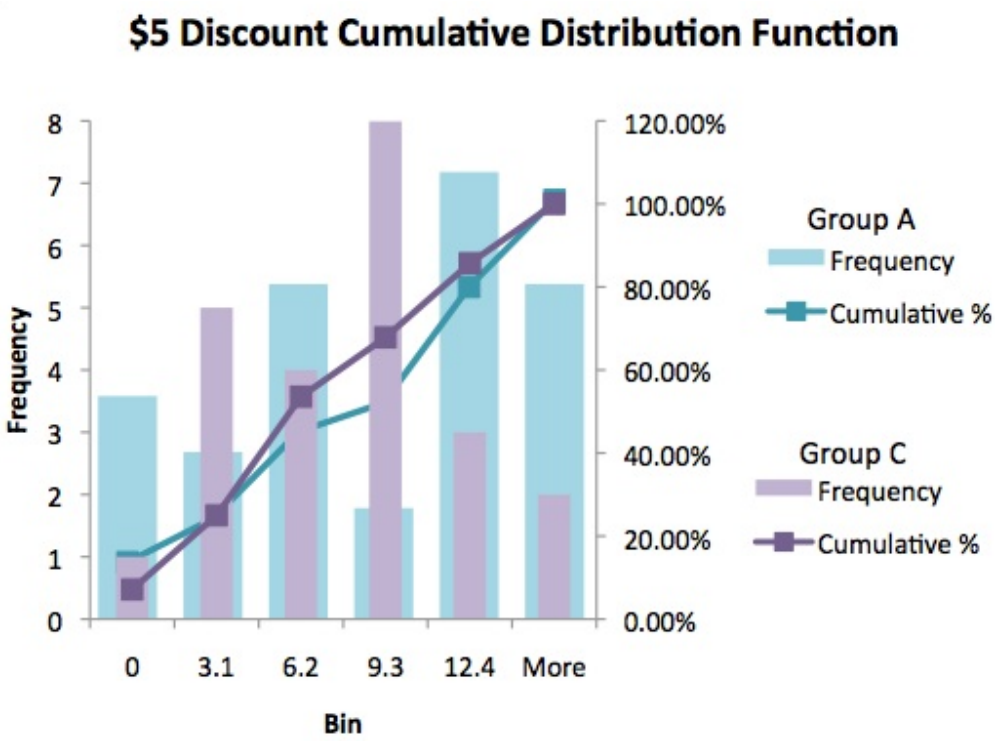

Figure 6: Cumulative Distribution Function for the $5 Discount WTP. Group A is represented by the blue and Group C is represented by the purple.

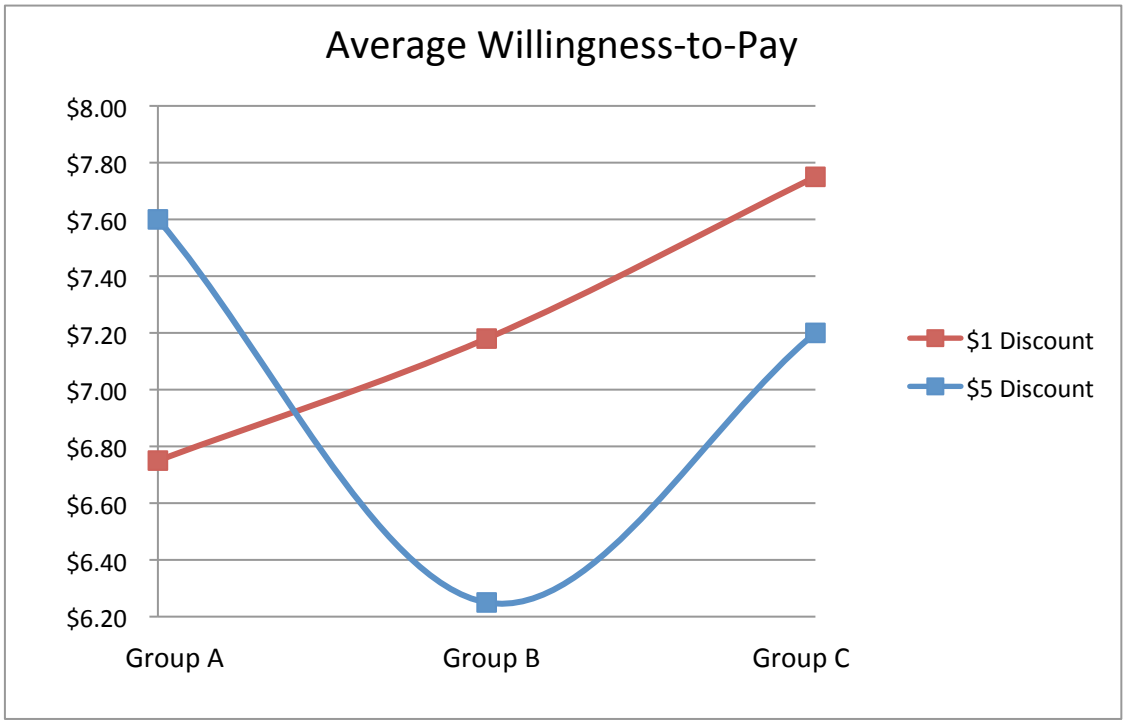

Figure 7: Graph displaying the mean willingness-to-pay results for Group A, B, and C.

Additional graphical representation of the willingness-to-pay data is presented in Figures 5-7. Figures 5 and 6 provide cumulative distribution functions that each compare the results from Group A compared to Group C (Group B was omitted from these graphs). The x-axis is the willingness-to-pay response of the subject and the y-axis measures the frequency with which that particular numerical response occurred. On the right side of the graph is a measure at any value of x of the cumulative percentage or the "area so far" under the monotonically increasing curve.

In Figure 7, the red line represents those who received the $1 discount and the blue line represents those who received the $5 discount. The x-axis refers to the time treatment (i.e. Group A, B, or C) and the y-axis displays the average willingness-to-pay for that group. As I predicted, there was an initial divergence in willingness-to-pay responses between those who received the $1 discount and the $5 discount, which I believed could be attributed to the disappointment or

satisfaction obtained from receiving those respective discounts. However, what I did not expect was the intersection of the two curves, much less the $1 discount curve rising above the $5 discount curve. Although I did not expect linearity between the duration of time spent with the new pricing information and the subject's willingness-to-pay, the parabolic shape of the $5 discount curve is especially notable. It would be interesting to see if over a sufficiently long period a convergence of the curves would occur at a WTP level similar to the WTP for a group that did not receive any discount information (i.e. whether the subjects' reference points would completely adapt to the discount eventually).

Regression Analysis

$$H_0: \beta_1 = 0, \beta_2 = 0$$

$$H_1: \beta_1 \neq 0, \beta_2 \neq 0$$

Qualitatively, the null hypothesis was that the amount of time you spend with new pricing information does not affect have an effect on willingness-to-pay. The alternative hypothesis was thus that time spent with new pricing information *does* affect willingness-to-pay. If the duration of time spent getting used to the new price is *not* playing a role in determining a consumer's willingness-to-pay, then there should not be a significant difference between the average responses from the three groups.

Table 5: **OLS Regression Results From $1 Discount Data.**

OLS, using observations 1-70
Dependent variable: WTP
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	6.75	0.822176	8.2099	<0.00001	***
Dummy_for_30_mi	0.425	1.13871	0.3732	0.71016	
Dummy_for_48_ho	1	1.18637	0.8429	0.40228	

Mean dependent var	7.185714	S.D. dependent var	3.985637
Sum squared resid	1083.763	S.E. of regression	4.021885
R-squared	0.011243	Adjusted R-squared	-0.018272
F(2, 67)	0.356817	P-value(F)	0.701223
Log-likelihood	-195.2152	Akaike criterion	396.4303
Schwarz criterion	403.1758	Hannan-Quinn	399.1097

Table 6: **OLS Regression Results From $5 Discount Data.**

OLS, using observations 1-72
Dependent variable: WTP
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.60345	0.965746	7.8731	<0.00001	***
Dummy_for_30_mi	-1.35345	1.2261	-1.1039	0.27349	
Dummy_for_48_ho	-0.407796	1.54728	-0.2636	0.79291	

Mean dependent var	7.097222	S.D. dependent var	4.940946
Sum squared resid	1711.309	S.E. of regression	4.980119
R-squared	0.012698	Adjusted R-squared	-0.015919
F(2, 69)	0.660633	P-value(F)	0.519760
Log-likelihood	-216.2241	Akaike criterion	438.4482
Schwarz criterion	445.2782	Hannan-Quinn	441.1672

Regression analysis was done using gretl 1.9.0 software. Two separate Ordinary Least Squares regressions were run (one for each the $1 discount group and the $5 discount group). Two indicators/dummy variables were created to represent the 30 minute and the 48 hour treatment groups. These dummy variables, along with the constant, were input as the regressors/independent variables and WTP (willingness-to-pay) was selected as the regressand/dependent variable. The use of these indicators was necessary because assuming linearity in time was not a good fit for the data.

The $1 discount regression results (see Table 5) have calculated the coefficient for Dummy_for_30_mi as .425, which means that Group B (30 minutes) had a WTP that was $.42 higher relative to the group with no time treatment (Group A). The coefficient for Dummy_for_48_ho was 1, which means that the difference between the Group C (48 hours) and Group A was $1. The p-values of .71 and .40 indicate that these differences were not statistically significant at the 5% level.

For the $5 discount group (see Table 6), the coefficient on the indicator/dummy variable for the 30 minute treatment (Group B) was -1.3. This means that the WTP for Group B was on average $1.30 lower than Group A. Additionally the coefficient on the indicator for the 48 hour treatment was -0.40, meaning that the average WTP for Group C was $0.40 lower than for Group A. The p-values of .27 and .79 demonstrate that these differences were also not statistically significant at the 5% level.

The high p-values that were generated by the regression led to a failure to reject H_0. The failure to reject the null hypothesis does not automatically deny the existence of a relationship between time and willingness-to-pay. What can be understood is that the data does not allow us to statistically prove a relationship at this point, as any variation in willingness-to-pay in this

study has a substantial probability of being due to random noise rather than correlation. Ideally, experimental refinements (in particular, a larger number of participants) could be used in future experiments of this kind to produce statistically significant results.

5 Policy Applications

Understanding how time factors into changing or forming reference points can lead to applications which extend past our initial goal of studying consumer behavior. As mentioned before, it is not only consumers who engage in reference-dependent behavior, but humans in general. Of course, it could be argued that the time involved in making decisions about willingness-to-pay might not translate perfectly into policy debates, but the underlying psychology in the experiment is clearly relevant for several issues. While this paper does not propose methods for changing the speed of forming or changing reference points, such applications would clearly require reliable measurements of those rates as a precursor, which this paper seeks to develop.

One policy subject that falls under the realm of consumer behavior is the excise taxes placed on cigarettes. Although in the experiment we studied how discounts affected willingness-to-pay, in a scenario regarding excise taxes on cigarettes it would essentially be the effect of a price *increase* on willingness-to-pay, given the initial reference point. For example, if cigarette consumers quickly adapt their reference points to the new price increases after the excise tax, then perhaps the intended effects (to reduce cigarette consumption and to encourage people to quit) will be weakened, as these consumers might not cut consumption but rather just purchase the cigarettes at the new price. In effect, over a period long enough for consumers to change their reference point, the demand curve becomes less elastic. If it takes consumers more time to

modify their reference point to this higher price, then purchasing cigarettes at the new price would feel like a relative loss for longer (the demand curve would remain relatively elastic for longer). If loss aversion with respect to money outweighs the need to fuel their addiction, then perhaps a reduction of cigarette consumption will occur. Although presumably, smokers are also averse to any loss in the number of cigarettes they smoke each day, i.e., going from three packs/day down to two packs/day would trigger its own loss aversion.

Furthermore, the temporal component of reference point fixation and modification would also be relevant for macroeconomic issues, such as unemployment. A common behavior of recently unemployed persons is to re-enter the job market seeking a position with a salary or wage level comparable to the one they previously held. Applying the idea of reference dependence, it makes a great deal of sense why a worker would do this: his reference point for income is dictated by his recent income $x. His reservation wage – that is, the minimum wage for which he will work – is equal to this reference point. Working for any amount less than $x would appear to the worker as a relative loss compared to his previous salary/wage. After spending extended amounts of time unemployed, workers' reference point either becomes $0, or equal to the unemployment benefits they receive (which we assume to be less than their previous income), which makes any job feel like a relative gain. Eventually, workers are weighed down by not having any income and compromise by taking a job with a pay level lower then they initially viewed as acceptable – their reference point has adjusted downward.

Based on this, it appears the frictional unemployment rate could be reduced if unemployed workers lowered their reference point more quickly. By reducing the time that

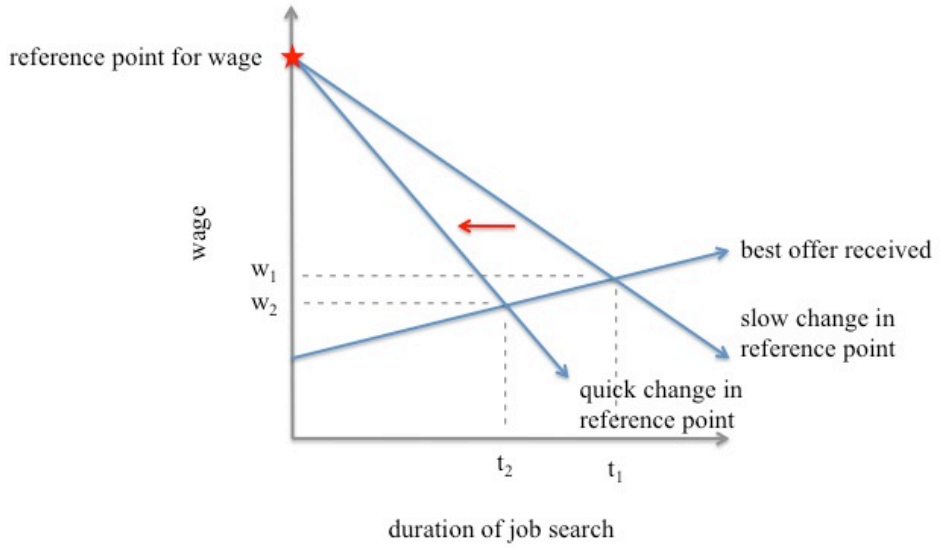

Figure 7: Graph of a Theoretical Job Search

frictionally unemployed workers spend searching for a job, the overall unemployment rate would fall. The workers would clearly benefit from this quick modification of their reference point as well, as it could mean that they would start working again much sooner than if they continued waiting for a position offering their reservation wage.

The above graph in Figure 7 is a visual representation of what an unemployed worker might encounter during a job search. The x-axis represents the duration of the job search and the y-axis measures wage. The "slow change in reference point" curve depicts the reservation wage curve for a worker who modifies his or her reference point slowly, and the "quick change in reference point" curve is representative of a worker who could quickly adapt his reference point. The "best offer received" curve is upward sloping because of the tendency that workers find higher-paying jobs when they spend more time searching. As demonstrated by the graph, even though both the worker who is able to modify his reference point for wage quickly and the worker who is not able to do so begin with the same initial reference point, the two individuals

end up in very different equilibriums, and correspondingly, lengths of job search and wages. Although the worker who could quickly change his reference point ultimately ends up with a slightly lower wage, he becomes employed much sooner than his slower counterpart. If acquiring a job sooner was ultimately more important to the worker than earning a slightly higher wage, then the ability to quickly adapt his reference point could be extremely beneficial. (It would also be possible to continue searching for a better job once employed, and any success would be perceived as a gain.) By reducing the length of time for workers to become re-employed, the overall unemployment rate for the economy could be decreased.

6 Conclusion and Suggestions for Further Research

In this paper I began by addressing the relevance of understanding the temporal component of reference dependence and outlining the previous research and models that had been proposed. I then completed an experiment designed to evaluate how different lengths of time between either perceived good or bad news, in the form of larger or smaller discounts on a product, affected people's modification of reference points, and presented the results and statistical analyses that were done on the data. Furthermore, I acknowledged policy issues, such as excise taxes on cigarettes and frictional unemployment, which could be affected by an improved understanding of reference-point adaptation.

Although the evidence does not prove anything, it does suggest that there might be differences; further research would be required to prove and accurately measure the periods of time in which adjustments to reference points occur. To better test this theory in the future, I would suggest several improvements. First, the number of subjects should be increased. 142 participants was not a manifestly insufficient number to run this experiment, but it would be

ideal if this experiment could have been run with even more subjects. Another suggestion would be the conduction of the experiment in a controlled social science laboratory, such as the Experimental Social Sciences Laboratory (Xlab) at UC Berkeley. Hopefully this could control for any discussion of the experiment between peers. Additionally, I would encourage the more random distribution of the discounts. Logistically it was easiest for me to have seat numbers on the chairs and as subjects came in the classroom I asked them to fill the next available seat (with the next seat number). This way when I went to assign the discount groups I could easily look at the last seat taken and divide N/2. This method also hopefully prevented the distortion of results that could occur from unintentionally separating the people who normally sit in the back of the classroom from the front-sitters. (Although presumably there could also be a difference between the behavior of those students that are the first to arrive to the class and those who arrive several minutes late.) Another issue with the numerical distribution may be the "herd mentality" associated with sitting next to people who all received the same discount. Perhaps the subject was desensitized to the disutility of receiving the $1 discount, as the subject was able to identify with the fact that other subjects nearby also were selected for the less desirable outcome. (Although I did hear some audible lamentations such as "aww man!" expressing disappointment when individuals realized they received the $1 discount.)

In this experiment subjects were asked to record their seat number on their surveys, so that I could later identify which of the two discounts they had received (I had recorded which seat numbers corresponded to each discount group in each section). In retrospect, it would have worked just as well, or potentially better, to have each subject just write either "$5 discount" or "$1 discount" at the top of the survey instead of their seat number (the seat number could still be used to divide the class into the two groups and assign their discounts). Perhaps the act of

physically writing down their discount would increase the sense of gain or loss relative to their reference point, and thus have a stronger effect on their purchasing decision, as they were forced to acknowledge it and visually see it on their paper (instead of the more abstract seat number which required looking at the chalkboard to see the range of seat numbers and the corresponding discount). A more pronounced gain or loss (and thus larger eventual adjustment to the reference point) could make it easier to tease out how the reference point adapts over time with high levels of statistical confidence. Finally, apart from refining the methods in the experiment proposed and conducted, those interested in conducting further research should consider implementing as many time treatment groups as possible, as 30 minutes and 48 hours alone proved inconclusive. This would be more practicable in a social science laboratory setting, another advantage of such a setting. In conclusion, the research advanced by this paper, as well as the additional potential for relevant policy applications, could be quite beneficial as economists become more concerned with addressing the underlying psychology involved in one of the central tenets of economics – how people make decisions.

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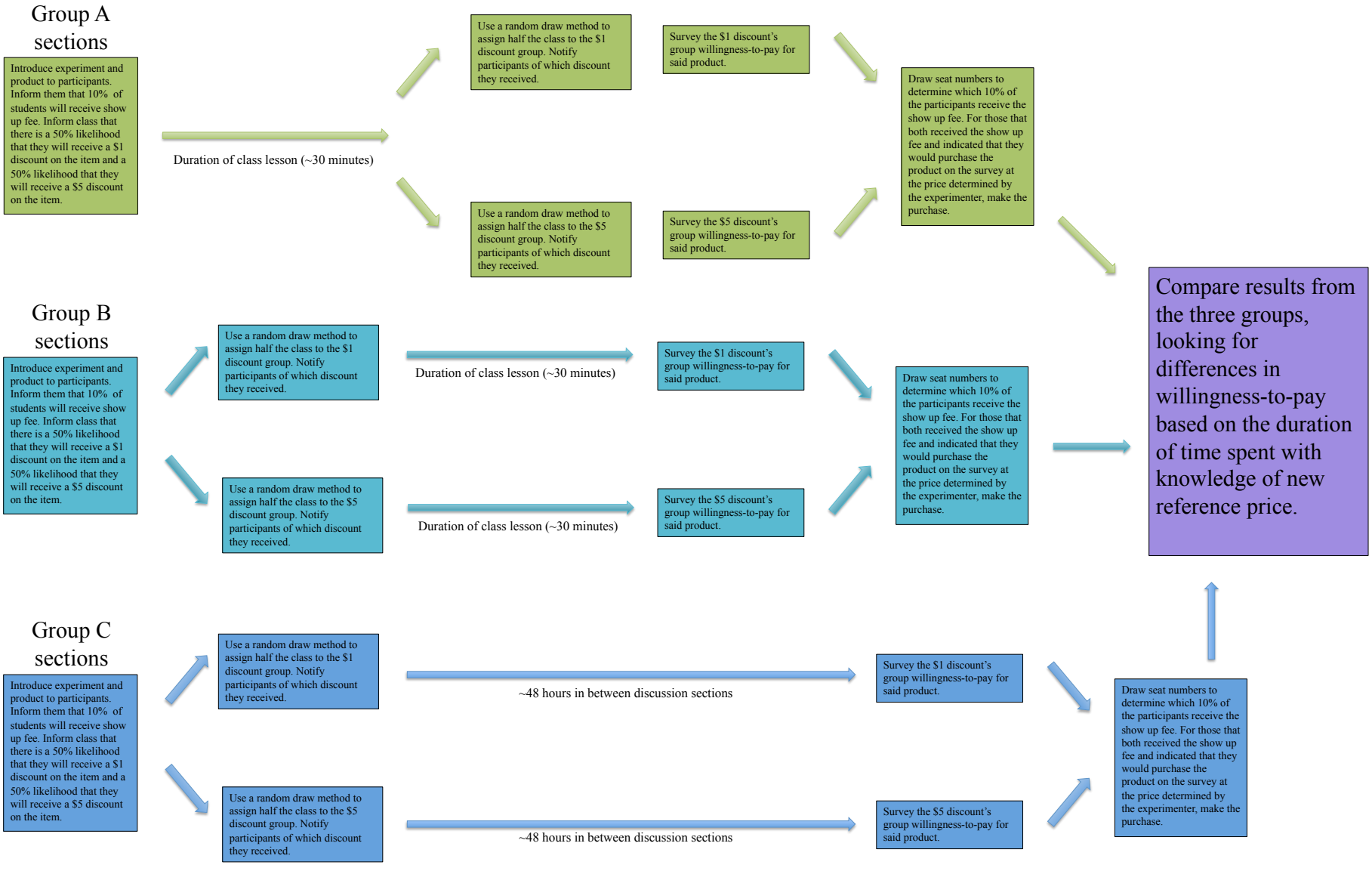
Visualizing the Experimental Procedure

Mikaela Aziz | Undergraduate Economics Thesis



Seat number: _____

Skullcandy INK'd Earbuds with In-Line Microphone

- 11 millimeter drivers with neodymium magnets for full-range sound
- Two sizes of silicone gel earbud sleeves for a perfect fit
- Mic with Control switch: In-line (on cord) mic, plus iPod Play // Pause // Track Control, 1.3-meter nylon braided cable with gold-plated 3.5mm plug
- In-ear design allows for passive noise isolation
- Frequency response: 20-20K Hz

Please complete the following. For each price, please indicate using complete honesty whether or not you would buy the product at that price, by circling either "buy" or "don't buy." If you are part of the 10% that receives the money, and you have circled "buy" at the price that is selected, you will be forced to follow through with the purchase. The show-up fee will be sufficient to cover the cost of the product, so that no one is forced to pay out of pocket for the purchase. Keep in mind: the price listed would be the price <u>after</u> discount.

Price of Product	Buy or Don't Buy	
$1.00	Buy	Don't Buy
$1.50	Buy	Don't Buy
$2.00	Buy	Don't Buy
$2.50	Buy	Don't Buy
$3.00	Buy	Don't Buy
$3.50	Buy	Don't Buy
$4.00	Buy	Don't Buy
$4.50	Buy	Don't Buy
$5.00	Buy	Don't Buy
$5.50	Buy	Don't Buy
$6.00	Buy	Don't Buy
$6.50	Buy	Don't Buy
$7.00	Buy	Don't Buy
$7.50	Buy	Don't Buy
$8.00	Buy	Don't Buy
$8.50	Buy	Don't Buy
$9.00	Buy	Don't Buy

$9.50	Buy	Don't Buy
$10.00	Buy	Don't Buy
$10.50	Buy	Don't Buy
$11.00	Buy	Don't Buy
$11.50	Buy	Don't Buy
$12.00	Buy	Don't Buy
$12.50	Buy	Don't Buy
$13.00	Buy	Don't Buy
$13.50	Buy	Don't Buy
$14.00	Buy	Don't Buy
$14.50	Buy	Don't Buy
$15.00	Buy	Don't Buy
$15.50	Buy	Don't Buy
$16.00	Buy	Don't Buy
$16.50	Buy	Don't Buy
$17.00	Buy	Don't Buy
$17.50	Buy	Don't Buy
$18.00	Buy	Don't Buy
$18.50	Buy	Don't Buy
$19.00	Buy	Don't Buy
$19.50	Buy	Don't Buy
$20.00	Buy	Don't Buy
$20.50	Buy	Don't Buy
$21.00	Buy	Don't Buy
$21.50	Buy	Don't Buy
$22.00	Buy	Don't Buy
$22.50	Buy	Don't Buy
$23.00	Buy	Don't Buy
$23.50	Buy	Don't Buy
$24.00	Buy	Don't Buy
$24.50	Buy	Don't Buy
$25.00	Buy	Don't Buy

$1 Discount Data

time	WTP
0	8.00
0	10.50
0	2.50
0	9.50
0	14.00
0	5.00
0	10.00
0	5.00
0	0.00
0	5.00
0	2.00
0	15.50
0	10.00
0	3.00
0	4.50
0	3.00
0	8.00
0	15.00
0	5.00
0	1.00
0	6.50
0	6.00
0	10.50
0	5.00
0	12.50
0	7.00
0	0.00
0	5.00
0.5	7.00
0.5	9.50
0.5	9.50
0.5	8.00
0.5	3.00
0.5	5.00
0.5	9.50
0.5	1.50
0.5	9.00
0.5	7.50
0.5	9.50
0.5	3.50
0.5	1.50
0.5	12.00
0.5	15.00
0.5	10.00
0.5	3.00
0.5	7.00
0.5	6.50
0.5	6.00

$1 Discount Data

48	7.00
48	10.00
48	9.50
48	7.50
48	18.00
48	15.00
48	9.00
48	9.00
48	7.00
48	11.00
48	3.50
48	4.00
48	11.00
48	10.00
48	3.00
48	3.50
48	6.00
48	5.00
48	5.00
48	10.00
48	5.00
48	1.50

$5 Discount Data

time	WTP
0	15.00
0	10.00
0	13.50
0	14.50
0	4.50
0	0.00
0	7.00
0	5.00
0	10.00
0	19.50
0	0.00
0	12.50
0	0.00
0	10.00
0	9.50
0	3.00
0	10.00
0	0.00
0	7.00
0	5.00
0	2.50
0	6.00
0	10.00
0	9.50
0	4.50
0	10.00
0	5.00
0	2.00
0	15.00
0.5	14.50
0.5	3.00
0.5	9.00
0.5	10.00
0.5	0.00
0.5	6.00
0.5	6.00
0.5	4.50
0.5	3.00
0.5	6.00
0.5	5.00
0.5	5.00
0.5	6.50
0.5	2.50
0.5	5.00
0.5	10.00
0.5	9.00
0.5	3.00
0.5	7.00

$5 Discount Data

0.5	10.00
48	7.50
48	2.00
48	4.50
48	25.00
48	2.50
48	2.00
48	1.00
48	7.00
48	1.00
48	9.00
48	9.50
48	0.00
48	10.00
48	7.00
48	5.00
48	12.00
48	7.00
48	8.00
48	5.00
48	4.50
48	9.00
48	7.50
48	19.50

The Temporal Component of Reference Point Determination

Mikaela Aziz
Senior Honors Thesis
Spring 2011

Introduction

- Thesis title: *The Temporal Component of Reference Point Determination*
- Thesis Advisor: Stefano DellaVigna, Ph.D.
- Important classes for this paper: Econ 100A, Econ 140 (Econometrics), Econ 119 (Psychology & Economics)

The Psychology of Reference Dependence

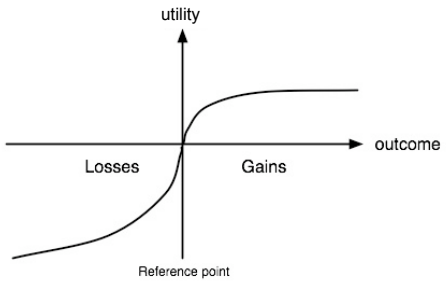
Source: Kahneman 2002

Although the inside squares are actually the same shade of gray, the one on the right appears much darker!

The Psychology of Reference Dependence

- Using relativity when making judgments is an innate human tendency
- Outcomes are not solely evaluated for the utility derived from them, but for the utility derived from the comparison between that event and another
- For example, we use reference-dependent preferences when evaluating utility in a risky situation or deciding whether to purchase a particular good

Expected Utility Theory vs. Prospect Theory



According to Expected Utility Theory we would expect this utility function to be a straight line.

Concavity in gain region in convexity in loss region: reflects diminishing sensitivity.

- Prospect Theory adds *loss aversion*: that we received more disutility from losses than we do utility from same-sized gains.

The Determination of Reference Points

- There have been many proposed theories as to *how* reference points are determined
  - Status Quo
  - Goals
  - Social Comparisons
  - Recent Expectations

Social Comparisons and Recent Expectations are being studied here

- Unfortunately there has minimal research on how quickly people establish their reference points, or modify existing reference points

THIS IS WHAT I'M INTERESTED IN STUDYING!

Experimental Method

Discussion sections faced one of three scenarios:

- 1/3 of sections received the discount information immediately before making a purchasing decision
- 1/3 of sections received the discount information at the beginning of class, and made the purchasing decision at the end
- 1/3 of sections received the discount information on the first day, and made the purchasing decision on their next section meeting (48 hours later)

- Becker–DeGroot–Marschak Method (BDM)

Experimental Method

- Not concerned with size of discount as much as the psychological effect it had on you and your willingness-to-pay for the product.
- $5 discount was meant to feel like a relative gain, $1 was meant to feel like a relative loss.
- Independent variable was **time** in between discount info and survey completion.
- Dependent variable was **WTP**.

Results

	$1 Discount	$5 Discount
n (number of subjects)	70	72
Min WTP	$0	$0
Max WTP	$18	$25
Mean WTP for Group A (t=0 minutes)	$6.75	$7.60
Mean WTP for Group B (t=30 minutes)	$7.18	$6.25
Mean WTP for Group C (t=48 hours)	$7.75	$7.20
Overall Mean WTP	$7.19	$7.10

So how much did the headphones really cost?
Retail price = $22.99

Policy Applications

	Job Market	**Excise Taxes on Cigarettes**
People who change their reference point **QUICKLY**	Might be able to find a job sooner, because they are willing to accept a lower wage than they previously earned	Might be able to adapt to higher price of cigarettes and thus will not cut their consumption
People who change their reference point **SLOWLY**	Might spend more time searching for a job	Might not be willing to pay the higher price, and thus cut consumption.

Advice for Future Thesis Writers

- **Take Econ 196** (Topics in Economic Research). It exposes you to a different professor's research each week, and requires you to write two papers on topics of your choice.
- **Start early!** Approach a professor whose area of interest and research is similar to your topic.
- If you decide to run an experiment, plan on getting your protocol submitted to the Committee for the Protection of Human Subjects **(CPHS)** as soon as possible.

THANK YOU!