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DO PSYCHOLOGICAL CUES ALTER OUR DISCOUNT FUNCTION?

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Previous psychology research has found that people respond to cue-based (i.e. visceral or instinctual) drives, which include hunger, thirst, sexual desire, pain, and fear, and that these cues influence our need for immediate gratification. These cue-based drives alter the extent to which we value rewards received at different time horizons. Economists have suggested that cue-based drives can alter a person's subjective discounting mechanism, making it deviate from the exponential discount model.

In this paper, I test the effect of a sexual stimulus on subjective discounting through a set of controlled experiments. I find that, in the presence of sexual stimuli, subjects' subjective discount rates become functions of time. When faced with a near future reward, subjects exhibit a greater discount rate, but when faced with the same reward in the far future, subjects exhibit a lesser discount rate. This is contrary to the traditional exponential discounting model, which assumes that the discount rate is constant with respect to time.

JEL Classifications: M3, D9, Z00

Key words: cue-based drives, visceral cues, discount function, discount rate, exponential discounting function, dynamic inconsistency

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I. Visceral Cues and Methods of Discounting

Visceral cues are instinctual drives that include hunger, thirst, sexual desire, pain and fear. Research suggests that the need for immediate gratification is more intense in the presence of cue-based drives, and that the desire to satisfy the need intensifies with time (Laibson, 2001; Loewenstein, 1996). This intensification of need over time is inconsistent with the traditional exponential discount function employed in economics and finance.

As the exponential discounting model is a straightforward means of converting between present and future cash flows, it is natural that economists would adopt this model to convert between present and future utilities. Exponential discounting, however, can preclude the modeling of cue-based behavior. For example, in assuming a constant discount rate, an exponential discounting model would under predict subjective discounting in shorter time horizons and over predict subjective discounting in longer time horizons when the subjective discounting is moderated by cue-based stimuli. Research suggests that a varying discount rate (for example, hyperbolic discounting) more accurately predicts time-based preferences (Angeletos et al., 2001; Caballero and Pride, 1984; Laibson, 1997, 2001; Loewenstein, 2000; Wilson and Daly, 2003). In other words, in the presence of cue-based drives, people tend to exhibit preferences for instant gratification when faced with a short-term reward, but prefer to exercise patience when faced with a long-term reward.

The purpose of this study is to test the hypothesis that subjects' subjective discount rates vary with time when the subjects are making cue moderated decisions but

do not vary with time when the subjects are making decisions that are non cue moderated decisions.

II. Literature Review

The literature on visceral cues and emotion in decision making spans psychology and neuroscience (Damasio 1994, 1996; Solomon 1980; McClure 2004). Neuroscientists have isolated the parts of the brain that govern emotion and higher cognitive thought and reasoning (McClure et al., 2004). In decision making, a cue is anything that excites a subject to action. A visceral cue is a cue that has an instinctual or emotive force to it such as hunger, thirst, sexual desire, pain, or fear (Loewenstein, 2000). Previous studies suggest that visceral cues activate and are governed by the *striatum* – the part of the brain responsible for feelings of reward, pleasure, fear, and addiction (McClure et al., 2004; Aharon et al., 2001; Laibson, 2001). In contrast, the *lateral prefrontal cortex* is responsible for higher cognition (McClure et al.; Aharon et al.). The striatum is heavily influenced by the levels of dopamine in the brain and, when stimulated by a visceral cue, it causes the subject to be more responsive to immediate gratification (Aharon et al.). The lateral cortex exhibits a more constant state in which it is capable of evaluating difficult decisions, future costs and benefits, and exercising patience (Aharon et al.).

Using the work pioneered in neuroscience on emotive factors, economists and psychologists have begun to work together in the study of emotive factors (which include visceral cues) and their effects on behavior and decision making (Loewenstein, 2000). Loewenstein observes that, until recently, economists have failed to include emotive factors in economic behavioral models. In assuming rationality, economic modelers often ignore the fact that cognition is costly and that, when the cost is high enough relative to

the benefit, humans will rely on non-rational approaches to decision-making (Davies and Cline, 2005). Visceral cues not only are cognitively inexpensive, but usually impact decision making at a subconscious level. Loewenstein claims that economic models that ignore visceral cues can fail to adequately predict consumer behavior.

From childhood we instinctually react to different visceral drives (Bugental et al., 1992). For example, a child does not have to be taught to feel hungry. If an infant has not eaten in a few hours it will begin to cry and will cry until its need is satisfied. We become conditioned to respond to certain stimuli that we know satisfy these drives. In the Theory of Classical Conditioning, the psychologist Ivan Pavlov manipulated stimuli through the pairing of cues to create what he termed "conditioned responses." Conditioned responses are created through the association of a neutral stimulus (any one thing that does not evoke response or emotion) with a significant stimulus (a stimulus that does evoke a response or emotion) (Pavlov, 1960).

Laibson (2001) developed the Cue Theory of Consumption in which he hypothesizes that the pairing of a cue with a consumption good creates a cue-based complement. For example, if someone is hungry and sees an advertisement for food (the cue) the complement would be satisfying that drive by consuming food. When a subject experiences a cue (i.e. the stimuli) the marginal utility of experiencing its complement increases (Laibson, 2001). The complement may be viewed as a reward, and therefore, the presence of a cue may produce an instinctual drive that makes it difficult for a subject to experience a delay in receiving the reward (i.e. the conditioned response). In other words, visceral cues trigger the need for immediate gratification and, as visceral effects

intensify, it becomes more difficult for the consumer to delay gratification (Laibson, 2001).

Visceral cues can explain much of the dynamic inconsistency that economists and psychologists observe in human behavior (Strotz, 1956; Loewenstein, 1996). Dynamic inconsistency occurs when decision maker's preferences are inconsistent over time. In the past, economists have used the exponential discounting function to compare utilities over time because this model is used in finance to compare future and present values and is, therefore, naturally applied to choice behavior. In assuming a constant discount rate, the exponential model is dynamically consistent (Strotz, 1956; Laibson 1998, 2001; Angeletos et al. 2001; Coller et al., 2005; Loewenstein, 1996).

Empirical evidence, however, suggests that human behavior is frequently dynamically inconsistent (Strotz, 1956; Thaler, 1994; Angeletos et al. 2001). Using the inconsistency displayed in savings behavior, Strotz examines why individuals impose rules on themselves to save and then change their decisions and plans over time. Strotz notes that only an individual who discounts exponentially will stick to the rules he laid out for savings. However, evidence that people do not stick to their plans for savings suggests that subjective discounting may not follow the standard exponential function.[1] This inconsistency in behavior is largely due to emotive factors that play a role in daily functioning (Loewenstein, 1996). Due to their influence on the need for immediate gratification, visceral factors contribute to problems with self-control (Angeletos et al. 2001, Laibson, 1997, 2001; Strotz, 1956). Economists call this an increase in the subjective discount rate.

[1] For a more detailed look at Strotz's theory on dynamic inconsistency and discounting see Strotz (1956) and Thaler (1994).

Experimental evidence suggests that the subjective discount rate is a negative function of the time horizon such that subjects tend to exhibit a preference for instant gratification when faced with short-term rewards, but not when faced with long-term rewards (Angeletos et al. 2001). Angeletos et al. note the disconnect between people's goals for the future and their short-run behaviors. For example, a consumer may express a desire to save for the future and may even lay out a specific target amount of savings, but in the short-run, the consumer uses credit cards (which act as a spending cue) to fund purchases that satisfy his preference for instant gratification (Angeletos et al., 2001).

Laibson (2001) notes the same inconsistency in dieting (a person may plan to eat a salad for lunch tomorrow but when lunch time comes he chooses to eat a cheeseburger instead) and in drug addiction (a drug addict makes up his mind to clean up but the minute he is given the chance to use the drug again, he reverts back to using the drug). Experiments examining the discount function and dynamic inconsistency in behavior have shown that observed subjective discounting fits a hyperbolic model (a model in which the discount rate varies over time) more closely than it does an exponential model (Strotz, 1956; Coller et al. 2005; Laibson 1997; Lowenstein, 2000; Angeletos et al., 2001).

It is important to note that not all non-exponential discount functions are strictly hyperbolic. Coller, Harrison and Rutstrom (2006) compare the exponential discounting model to the quasi-hyperbolic discounting model - which assumes that subjects have "fixed premiums" for a short-term time horizon, but that after this initial short-term period subjects switch to a constant discount rate when facing a long-term time horizon. The study tests which model, in the absence of visceral cues, better fits observed

subjective discounting of monetary rewards. Coller et al. asked students questions that for which there were varying monetary rewards at varying time horizons. Their experiments allow them to estimate which discounting model was used by each subject, and they find that some subjects use exponential discounting while some use quasi-hyperbolic discounting. It is important to note, however, that the exponential discounting function is a special case of the quasi-hyperbolic discounting function and therefore, when subjects are asked questions regarding long-term rewards, the result is a constant discount rate regardless of which model is being used. Because of this, some researchers prefer to compare the exponential and hyperbolic discounting functions, particularly when studying the effects of visceral cues on discounting (Laibson, 2001; Angeletos et al. 2001; Loewenstein, 2000; Benhabib et. al, 2007).

The study of visceral effects and non-exponential discounting also extends to the study of relationships and mating behavior. Loewenstein and Ariely (2006) study 35 male college students. The purpose of the study is to examine male preferences for a wide range of sexual stimuli, willingness to engage in morally questionable behavior and their willingness to engage in unprotected sex. Loewenstein and Ariely measure the abilities of the subjects to recognize the influence of sexual arousal on their behavior and decisions. If sexual arousal in fact does affect an individual's behavior and decisions, it is likely that he/she is not consciously aware of, and therefore underestimates, the effect. They find that in this state of arousal, activities that were not attractive in a non-arousal state become attractive, and that subjects underestimate the impact of sexual arousal on their decision making. Lowenstein and Ariely argue that sexual drive and motivation impact,

among others, teen pregnancy, date rape, and pornography, and that awareness of the effect of sexual motivation can help individuals counteract the effects.

Studies have shown that mating cues have practical implications for marketing as well. The visceral effect of a mating cue can also affect the probability of purchase, particularly of "high-status" consumer goods (Janssens et al., 2009; Caballero and Pride, 1984). In order to examine this effect on the consumption of high-end consumer goods, Janssens et al. conduct two experiments using pictures of sexy women and a real-life model. Similarly, Caballero and Pride (1984) use pictures of the opposite sex to examine the probability of purchase. Both studies find that men are more attentive to high-status products and more likely to purchase high-status products when exposed to both pictures of women and real-life models. It is interesting to note that this result is exclusive to men. There are numerous hypotheses as to why visual stimuli have a greater impact on males than on females. Women are known to place greater emphasis on non-physical characteristics such as ambition, social status, kindness, and the ability to provide security, whereas men find the attractiveness of the female to be of greater importance (Janssens et al., 2009; Waynforth, 2000; Roney, 2002). Drawing on previous research on these gender differences, Janssens et al. hypothesize that the importance of attractiveness to men is due to an evolved natural instinct for reproduction and that attractiveness has an intense visceral effect (specifically, a mating cue effect) that evokes this instinct.

Wilson and Daly (2003) examine the effect of mating/relationship cues on discounting in males by conducting an experiment to examine how exposure to a "mating opportunity" alters men's discount rates. Similar to Laibson's findings, Wilson and Daly

find that visceral cues cause people to discount differently, suggesting that discounting "varies adaptively".

Given this background, I examine how emotive/visceral cues activated by sexual stimuli alter the discounting function. Specifically: Is the behavior following the stimuli no longer consistent with exponential discounting?

III. Methodology

I conducted an experimental study to test the effects of visceral cues on discounting in males. This experiment is designed to test how sexual stimuli alter the way an individual discounts present and future rewards.

A. Hypothesis

I hypothesize that the visceral cue of sexual stimuli alters the discounting function in such a way that the function no longer follows the exponential discounting model. I hypothesize that, when single, heterosexual, young adult male subjects are exposed to a mating cue, they will discount the future more heavily than they will in the absence of the cue.

After having been told that there are no risks or transaction costs associated with receiving a prize, subjects were told to select which of two prizes they would like to receive if they were selected to receive a prize: a smaller prize payable X days in the future, or a larger prize payable $X + K$ days in the future. If subjects discount exponentially, we should observe the same proportion of subjects choosing each prize *regardless* of X – i.e., the subjective discount rate should be time invariant. I hypothesize that subjects' discount rates will be time invariant when subjects do not receive visceral

stimuli. In the presence of visceral stimuli, I hypothesize that subjects' discount rates will be greater at lesser time horizons.

B. Experiment

For visceral cues, I chose to examine sexual stimuli cues, or "mating-cues", in anticipation of these being more relevant to my subject pool (male college students).[2] I created four online variations of a short survey: short-horizon control, short-horizon manipulation, long-horizon control, and long-horizon manipulation.

Each survey was four pages long and consisted of instructions and a question asking the subject to select from one of two prizes. Following the survey, subjects answered several demographic questions. In the two manipulation surveys, a picture of a different attractive woman appeared on each of the four pages of the survey. In the two control surveys, the pictures of the four women were replaced with four pictures of Tupperware (an object intended not to elicit a visceral response) in approximately the same sizes and color tones.

I conducted a pretest in which subjects were asked to rate the women's pictures on a seven-point Likert scale (from very unattractive to very attractive). The four pictures that received the highest attractiveness ratings appeared in the survey.

In the short-horizon surveys, subjects were asked to choose one of two possible prizes: $10 payable tomorrow, and $20 payable three months from today. In the long-horizon surveys, subjects were asked to choose one of two possible prizes: $10 payable three months from today, and $20 payable six months from today.

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[2] For other visceral stimuli, see Loewenstein (1996, 2000, 2006), Aharon et al. (2001), Laibson et al. (1998), and Roney (2003).

The surveys were administered on computers in a computer lab. One-hundred and thirty-two male college students were surveyed and each subject completed only one of the four variations of the survey. The surveys were arranged on the computer screens so that no subjects were aware of any other variations of the survey. In order to increase subject involvement, each subject placed his name and address on an envelope when entering the room. It was then explained to the subjects that, at the end of the survey an envelope would be randomly drawn from the box. The subject whose name would be drawn would receive the prize that he chooses in the survey.

Table 1: Surveys, Rewards, and Stimuli

Survey	Reward	Stimuli
Control, Short Horizon	**Prize W** - $10 payable tomorrow **Prize X** - $20 payable 3 months from today	Tupperware
Control, Long Horizon	**Prize Y** - $10 payable 3 months from today **Prize Z** - $20 payable 6 months from today	Tupperware
Manipulation, Short Horizon	**Prize W** - $10 payable tomorrow **Prize X** - $20 payable 3 months from today	Women
Manipulation, Long Horizon	**Prize Y** - $10 payable 3 months from today **Prize Z** - $20 payable 6 months from today	Women

After answering the monetary reward questions, the subjects were asked to indicate their sexual orientation, race and age. In addition to these questions, at the end of the survey, participants of the control groups were shown the four pictures of the women that appeared in the manipulation surveys and were asked to rate their attractiveness on a seven-point Likert scale. Subjects were instructed throughout not to go back and change answers they had already provided

IV. Results and Analysis

In the Short-Horizon Control Survey, 45.5% of the subjects chose the less delayed option ($10 payable tomorrow). In the Long-Horizon Control Survey, 31.3% of the subjects chose the less delayed option. The difference in the two proportions was insignificant (p = 0.117).

In the Short-Horizon Manipulation Survey, 55.9% chose the less delayed option, versus 25.8% in the Long-Horizon Manipulation Survey The difference in proportions is significant (p = 0.004). These results are summarized in the following table.

Table 2: Number of Subjects

	Control	Manipulation
Short Horizon	33	34
Long Horizon	32	31

Table 3: Proportion of Respondents Choosing the Less Delayed Option

	Control	Manipulation
Short Horizon	45.50%	55.90%
Long Horizon	31.30%	25.80%

In addition, the proportion choosing the less delayed option in the Short-Horizon Control Survey (45.5%) was not statistically different from the proportion choosing the less delayed option in the Short-Horizon Manipulation Survey (55.9%) (p = 0.804). Likewise, there was no statistically significant difference in the proportion choosing the less delayed option in the Long-Horizon Control Survey (31.3%) compared to the Long-Horizon Manipulation Survey (25.8%) (p = 0.314).

	Proportions That Selected Less Delayed Options		
	Short-Term	Long-Term	**P-values for Short-Term versus Long Term**
Control	45.5%	31.3%	**0.117**
Manipulation	55.9%	25.8%	**0.004**
P-value for Control versus Manipulation	**0.804**	**0.314**	

Table 4: Calculations for control and manipulation surveys

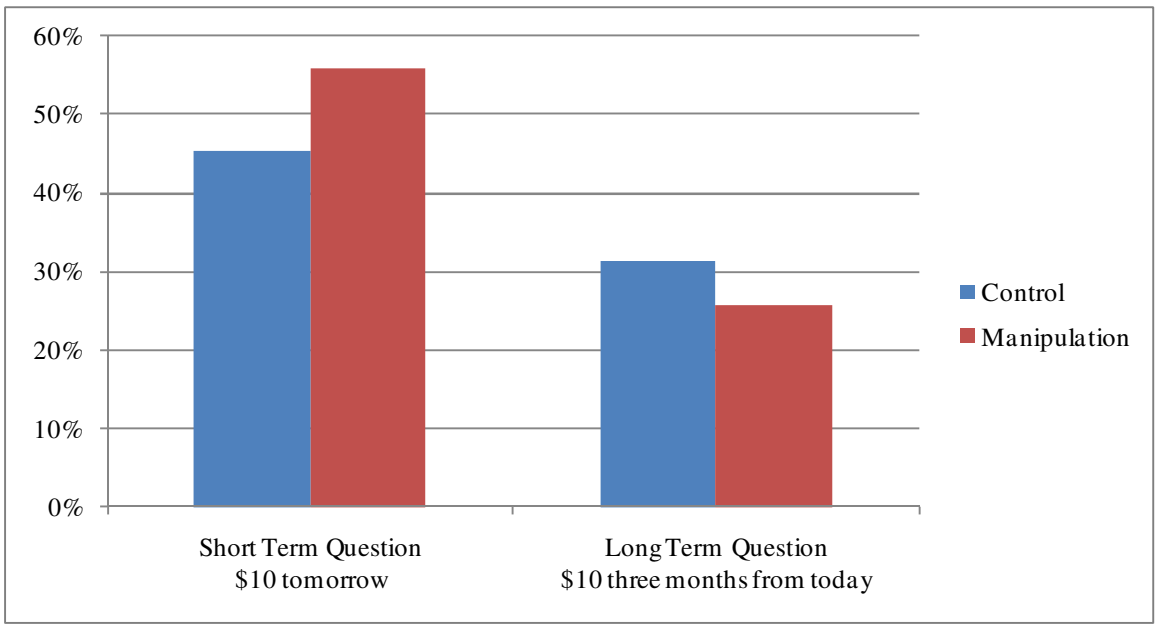

Figure 1: Proportions of Subjects Who Chose Less-Delayed Option

Lastly, a one-tailed t-test was conducted to test if the average rating for each woman's picture was greater than four. All of the pictures have an average attractiveness rating of five or greater and are statistically significantly greater than four at a 1 percent level of significance.[3] Two subjects reported having a sexual orientation other than heterosexual. These two subjects were removed from the data set.

V. Economic Implications

The results of this study suggest that, in the presence of visceral cues (specifically, sexual stimuli), subjects' discount function may change such that the exponential model ceases to describe the subjects' behaviors. The results of this study provides a behavioral explanation for research by Caballero and Pride (1984) and Janssens et al. (2009) that found that men are more attentive to high-status products and more likely to purchase high-status products when exposed to both pictures of women

[3] Woman 1: Average rating = 5.2, p-value = 0.000. Woman 2: Average rating = 5.9, p-value = 0.000. Woman 3: Average rating = 5.0, p-value = 0.000. Woman 4:Average rating = 5.3, p-value = 0.000.

and real-life models. The results of my study suggest that sexual stimuli can cause males to place greater weight on immediate gratification, possibly making the purchase associated with the sexual stimuli more attractive or desirable than it may have been otherwise relative to longer term tradeoffs.

Research in psychology, behavioral economics, and behavioral finance seek to understand seemingly irrational behavior (dieting behavior, drug addiction, exercise, sexual behavior, investing behavior). Understanding that visceral cues can alter our discount functions may provide a basis to for reformulating seemingly irrational behavior as fundamentally rational when viewed in light of a more complex discounting process. For example, research shows that people pay for sale items on credit cards but do not factor in the enormous interest payments that they are often incurring by doing so. Feinberg (1986) finds that credit cards act as a cue that facilitates spending. Previous research shows that in the presence of credit card cues, individuals are not only more likely to spend, but spend more and spend more impulsively. The way in which individuals use credit cards to finance immediate gratification and impulse buying cannot be accurately explained by the conventional discount model (Brown and Plache, 2006). However, my research suggests that such behavior may be explained by visceral cues that alter the buyers' discounting functions.

Similarly, researchers note an inconsistency in savings behavior in which people report a disconnect between their intentions to save and their actual savings behavior. In surveys on savings, 55 percent of respondents claim they are "behind" in their savings for retirement, whereas only 6 percent claim that they are "ahead" in their savings (Angeletos et al., 2001; Farkas and Johnson, 1997). Exponential discounting models cannot explain

this disconnect. If people's discounting functions are not exponential, it is possible that there is no disconnect but rather what we observe is the result of a time varying discount rate.

VI. Suggestions for Future Research

It would be interesting to observe whether and to what extent visceral cues vary in their effect across varying educations, ages, and genders. If it is the case that more educated subjects are less susceptible to visceral stimuli effects, then a possible "antidote" is targeted education (for example, clearer communication of credit card interest rates, rates of return on retirement savings, etc.). If, however, more educated subjects are equally susceptible, then it may be the case that education can lull people into a false sense of "immunity" to visceral stimuli.

Future research might also focus on the effects of other visceral cues on the discount function. Wilson and Daly (2003) were the first to document an experimentally altered discount rate through the introduction of sexual stimuli cues. It may be the case that other visceral stimuli have different effects on the subjective discount rate under (possibly) different circumstances.

VII. Conclusion

The purpose of this study was to test the hypothesis that visceral cues, specifically sexual stimuli, can alter the discount function such that it no longer follows an exponential model. If cues can indeed alter the way we value future rewards, it is possible that one discounting model will be unable to predict sufficiently the dynamic inconsistency in behavior caused by these cues. I find that, when subjects are exposed to

sexual stimuli, their discount functions alter such their subjective discount rates increase for shorter time horizons but not longer time horizons. This is consistent with previous research that suggests that visceral cues activate the need for immediate gratification. My findings support Lowenstein's (2000) suggestion that economists should account for visceral cues and their effects on behavior and decision making.

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Appendix A

Hypothesis for attractiveness rating:
Null Hypothesis: $t <= 4$
Alternative Hypothesis: $t > 4$

Girl 1:

Average	n	df	Test Statistic	p-value
5.2	65	64	8.231	0.000

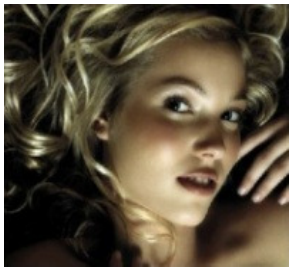
Girl 2:

Average	n	df	Test Statistic	p-value
5.9	65	64	10.622	0.000

Girl 3:

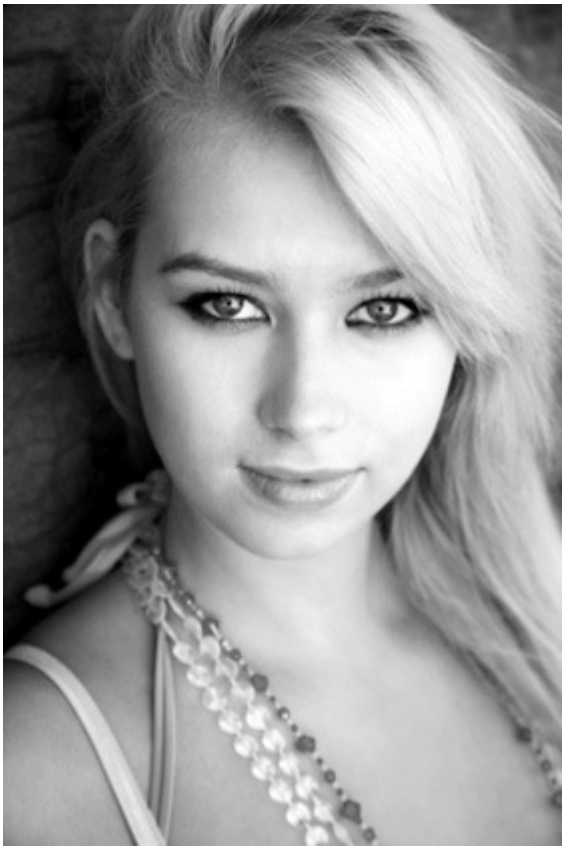
Average	n	df	Test Statistic	p-value
5.0	65	64	6.073	0.000

Girl 4:



Average	n	df	Test Statistic	p-value
5.3	65	64	7.530	0.000

Appendix B



Appendix C

Control Short-Term Survey and Control Long-Term Survey

Difference in Proportions Test			
p_1	0.455	Stdev(p1 - p2)	0.119
N_1	33	Test statistic (distributed stnd norm)	1.190
p_2	0.313		
N_2	32		

Standard Normal Distribution (Z)	
Test statistic	1.190
Pr(Z > Test statistic)	11.70%
Pr(Z < Test statistic)	88.30%

Manipulation Short-Term Survey and Manipulation Long-Term Survey

Difference in Proportions Test			
p_1	0.559	Stdev(p1 - p2)	0.116
N_1	34	Test statistic (distributed stnd norm)	2.598
p_2	0.258		
N_2	31		

Standard Normal Distribution (Z)	
Test statistic	2.598
Pr(Z > Test statistic)	0.47%
Pr(Z < Test statistic)	99.53%

Control Short-Term Survey and Manipulation Short-Term Survey

Difference in Proportions Test			
p_1	0.455	Stdev(p1 - p2)	0.122
N_1	33	Test statistic (distributed stnd norm)	(0.856)
p_2	0.559		
N_2	34		

Standard Normal Distribution (Z)	
Test statistic	(0.856)
Pr(Z > Test statistic)	80.40%
Pr(Z < Test statistic)	19.60%

Control Long-Term Survey and Manipulation Long-Term Survey

Difference in Proportions Test			
p_1	0.313	Stdev(p1 - p2)	0.114
N_1	32	Test statistic (distributed stnd norm)	0.484
p_2	0.258		
N_2	31		

Standard Normal Distribution (Z)	
Test statistic	0.484
Pr(Z > Test statistic)	31.42%
Pr(Z < Test statistic)	68.58%