The Effects of Anticipated Regret on Decision-Making

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Abstract

Feeling regret is a common experience most people have upon realizing an alternative choice would have been the better decision. People also tend to incorporate the possibility of experiencing future regret to make present-time decisions, such as choosing food at a restaurant or making investment decisions. However, it is unclear whether this process of thinking about the potential regret is a fully cognitive process, or if it actually recruits emotional processes to simulate how painful the future regret might be. To test this idea of whether anticipated regret has similar emotional signatures as experienced regret, we used the two following experiments. In Experiment 1, participants made decisions between two gambles on different levels of noxious thermal heat stimulation. In Experiment 2, participants made decisions between two monetary losses. In both cases we recorded participants' autonomic arousal through heart rate and skin conductance response, as well as their facial expressions, while they make decisions between gambles. While some participants showed psychophysiological responses associated with regret, there is no robust evidence that the responses were correlated exclusively to anticipating regret. Moreover, we actually observed risk-seeking behavior in participants' gamble choices. These results showed that anticipated regret is not clearly used in the decision-making process, and does not elicit physiological responses prior to decisions.

Introduction

Regret touches many part of our lives, such as shopping for consumer goods (Simonson, 1992, Shih & Schau, 2011) as well as reminiscing past actions and inactions (Gilovich & Medvec, 1995). Imagine you stop by your routine coffee shop while running late to work one day. Two lines of people are already waiting to place an order. Contemplating between the two lines, you finally decide to wait in line 1. As you nervously stare at the clock, the person a few spots ahead of you begins to holdup the line as they can't make a decisive order. Meanwhile, customers in line 2, including the person that walked in five minutes after you, have already finished making their order. In this scenario, would you regret your choice in line 1? Regretful situations focus one's attention in a way that can produce aversive psychological effects. Still, regret remains outside of the six universal emotions and exists as a "complex emotion". While universal emotions (happy, sad, anger, fear, disgust, surprise) describe human responses that have distinct physiological signatures seen across all cultures, "complex" emotions lack objective attributes. For this reason, complex emotions typically don't occur automatically without cognitive processing or explicit self-reflection. The complexity of the emotion makes regret a difficult feeling to objectively define. This is due to the ambiguity of the emotion that depends highly on the context. Therefore, in this context, regret is measured by an induced feeling of sadness or repentance over a foregone opportunity that objectively has a more favorable outcome than the chosen and obtained opportunity (Bell, 1982). This definition allows us to objectively induce, measure, and analyze the emotion within the context of our two paradigms.

Counterfactual thinking compels one to recall a past alternative outcome and compares it to their contrary obtained outcome while dwelling over a thought of "what ifs" (Camille, 2010). Though regret is induced through the comparison of counterfactual outcomes of alternative choices, we then define disappointment as receiving an outcome that simply doesn't meet your expectation. For example, imagine selecting one of two gambles, disappointment arises when the alternative outcome is better than your obtained outcome within your selected gamble. However, you don't ever see the outcome of the alternative gamble choice. The magnitude of disappointment is measured through the degree of discrepancy between your obtained outcome and the alternative outcome in your gamble. Regret depends on counterfactual processing that is emotionally induced when comparing a better outcome with an alternative choice. The magnitude of regret depends on the difference between your obtained outcome and your alternative unselected outcome. Thus, the main differences between disappointment and regret is that regret is associated with a feeling of responsibility due to having received the opportunity to choose a more favorable outcome at one point (Bault, 2016). Recent research uncovered the neural correlates of regret and its influence in a simple gambling task (Camille et al, 2004; Coricelli et al, 2005).

This experiment extends on two research papers on this specific topic by Nathalie Camille et al. (2004), and Giorgio Coricelli et al. (2005). Camille's paper primarily concentrates on the neural basis of regret. Camille's study showed the absence of regret and processing of counterfactual feedback in decision-making within patients with orbitofrontal cortex lesions, suggesting the importance of the orbitofrontal cortex in applying counterfactual knowledge. The authors also use a logistic regression model to investigate the influence of expected value, anticipated disappointment, and anticipated regret on decisions on a trial-by-trial level.

Coricelli's paper concentrates on regret and its avoidance. Using the same two-wheel experimental design as Camille's research, Coricelli uncovers the neural activity of risk-aversive decision-making. He utilizes self-reporting scales and fMRI data to measure the various degrees of regret felt by his subjects. His use of an fMRI provides further insight into the ways the orbitofrontal cortex and anterior cingulate activity can contribute to regret and risk-aversive decision-making. However, whether this anticipated regret is similar to the actual experience of regret, and whether it is the actual simulation of regret that prompts the subject to avoid it remains an open question.

We experiment with the objective of comparing subjects' responses, through Skin Conductance Response (SCR), heart-rate, and facial recordings of anticipated and experienced regret. Comparing the recorded responses and seeing the correlating decisions made along with their responses gives further insight in determining the significance of anticipated regret, and ultimately how it affects decision-making. Moreover, Camillie and Coriculli's research do not report any neural or physiological signatures at the time of choice that may be correlated with anticipated regret. Thus, it remains unclear whether the anticipation of regret is the same as the experienced regret through distinctive psychophysiological signatures before the decision. I investigate if anticipated regret is an actual emotional experience akin to the experience of regret or if it is a purely cognitive process comparing counterfactuals (Frijda, 2004; Zeelenberg et al., 2007). Camille and Coricelli focus on the effects of anticipated regret post-decisions, yet ignore the actual effects of anticipated regret pre-decisions. Thus, whether or not regret provokes cautioning physiological signatures before a decision is made remains uninvestigated. My work hopes to fill this gap in the literature by examining the effects that regret produces pre-decision in the hopes of capturing psychophysiological and facial expressional signatures of anticipating

regret. Simultaneously, I explore the characteristics of those signatures and compare the differences with experienced regret, while also considering disappointment, in order to answer the following questions: Does anticipated regret have distinct psychophysiological signatures that differ from experienced regret? To what capacity do participants think about regret and disappointment in their decision-making?

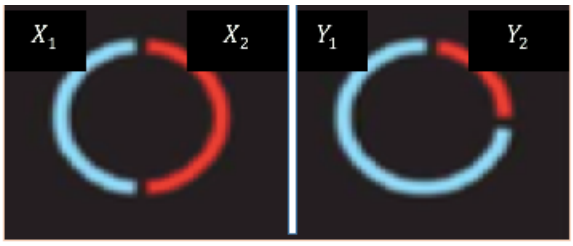
My experiment aims to 1) replicate the effect of anticipated regret on decision making, 2) compare the psychophysiological signatures of anticipated regret and experienced regret, and 3) compare the facial expressions for anticipated and experienced regret. With the exception of a few modifications, the experimental design mimics Camille's two-wheel gamble experiment using monetary rewards as an incentive. Additionally, I ran a second paradigm to the main experiment, except substituting monetary rewards with pain inducement. In effect, subjects aimed to avoid greater amounts of pain rather than aiming to retain monetary payoffs.

While many researchers have examined regret through monetary incentives, none have used incentives that produce a visceral response. The use of a primary reinforcers assures that participants have a reason to take each trial seriously in a way that material objects could never incentivize. Furthermore, the visceral factor of pain heightens the displeasure (Loewenstein, 2000) of results more than a slight monetary reward, since anticipated regret is proposed to be elicited when negative consequences from wrong decisions materialize immediately (Janis & Mann, 1977). Visceral factors can alter desires rapidly because they themselves are affected by changing internal bodily states and external stimuli (Loewenstein, 2000). As a result, if distinct psychophysiological signatures for anticipated regret do exist, using a primary reinenforcer allows the best chance for these responses to be induced.

The pain is administered through a Thermode designed by the Medoc PATHWAY thermal stimulation system. This version of the experiment allows us to examine anticipated regret from a different angle that might make this complex emotion more apparent. Furthermore, the results of this experiment are then examined with the monetary paradigm to see if the results are identical or different and discuss the reasons behind the variations.

In both studies, regret was distinguished from disappointment by creating two conditions. In partial feedback, participants saw the outcome of their selected gamble. Each "wheel" is referred to as a gamble due to the random outcome that occurs. While in complete feedback, participants saw their selected outcome as well as their unselected alternative outcome. Partial feedback induces a feeling of disappointment because participants only witness the obtained outcome that would not have met expectations. However, complete feedback induces a feeling of regret by allowing the participant to witness both outcomes; thus, allowing the participant to recognize an alternative outcome more favorable than the obtained outcome. Regret, disappointment, and expected value are defined through the following equations for both paradigm using the two gamble wheels (Figure 1):

Figure 1. *Two-pin wheel gamble (Coricelli et al, 2005)*



Assuming X_1 is a better outcome than X_2, and Y_1 is a better outcome than Y_2.

Regret: $R = |Y_1 - X_2| - \lfloor X_1 - Y_2|$
Disappointment: $D = |Y_1 - Y_2| - \lfloor X_1 - X_2|$
Expected Value: $E = \left(X_1 * P_{X_1} + X_2 * P_2\right) - \left(Y_1 * P_{Y_1} + Y_2 * P_{Y_2}\right)$

$*P_{choice} = Probability\ of\ that\ sector\ being\ chose$

I hypothesized that anticipated regret would have an impact on future decision-making through consistent psychophysiological responses before decisions. However, I predicted the

apparent physiological responses differ from the responses of their experienced regret. After a subject's initial obtained outcome is more disadvantageous than the unattained outcome (regretful moment), I thought SCR responses would increase pre-decision as subjects begin to assess their most recent regretful decision; thus, in agreement with Coricelli, I believed anticipated regret would increase with time. I predicted this is consistent between using the pain and monetary incentives. In regards to facial expressions, I anticipated more consistent facial pattern would be discovered when dealing with pain incentives, due to the visceral factor. However, using both incentives, I thought we would find evidence of distinct facial expressions for anticipated regret and experienced regret. Furthermore, I thought the facial responses' pattern of occurrence would match that of their physiological responses from the SCR.

The experiments showed that anticipated regret is not a critical decision factor when gambling in a loss domain. While a handful of participants used regret in the pain paradigm, this may be attributed to the visceral factor of the experiment. Moreover, participants showed no significant psychophysiological responses correlated to anticipated regret, and nothing explicitly distinguishing it from experienced regret. The facial analysis further supports the results as no distinct facial patterns were found between anticipated and experienced regret. While anticipated and experienced regret clearly had different levels of facial activity, there is no significant correlation these results are linked to anticipating or experiencing regret. Thus, while some slight signatures of anticipated regret can be inferred, the experiments suggest that anticipated regret is a subtle cognitive processing that is not prioritized in the decision-making process or induces psychophysiological responses.

Experiment 1

Experiment 1 tests the hypothesis that people have psychophysiological responses through anticipated regret in decision-making. Using thermal stimulation as our method of "pain", subjects chose between two gambles of pain induction. Each participant received thermal stimulation at the end of each trial. Pain allows for a negative consumptive experience that has the potential to induce great visceral response. Thus, natural pain-avoidant behavior incentivizes participants to choose a gamble that they believe offers them the best chances of receiving the least amount of pain. In the complete feedback condition, we hoped regret became evident as participants can began to see their alternative outcomes, unlike the partial feedback condition. In the end, comparing choice predictions with psychophysiological responses allows us to explore people's responses when faced with decision-making gambles that risk their well-being.

Methods 1

Subjects

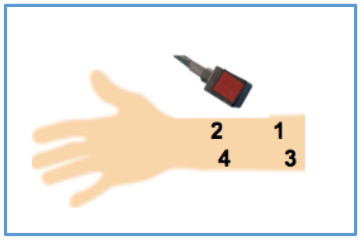
Forty-one healthy subjects completed the experiment (25 males and 19 females, mean age = 21.1, Standard deviation = 1.1). All subjects attended Dartmouth College, and were recruited through an online posting and various social media outlets. Subjects were paid $10 for their participation. One person was unable to fully complete the experiment due to a crash in the program. One facial video recording was lost and one recording started after the synchronization sound and thus was omitted from the analysis. Each participant provided informed consent before beginning the experiment. The experiment was approved by the Institutional Review Board (IRB) of Dartmouth College, and funded by a grant from the office of Undergraduate Research of Dartmouth College.

Experiment Paradigm

Participants were given two choices of gambles. Each gamble had two possible outcomes with different temperatures. The probability of each outcome was depicted by a colored area of the circle. Following instructions and questions, participants repeatedly picked one of two gambles designed with a set of temperature values [44C, 45C, 46C, 47C, 48C] paired with probability values [.9/.1; .7/.3; .5/.5]. The higher the temperature, the greater the thermal stimulation. At the beginning of each trial, two gambles were displayed on the computer screen. The participants used the mouse to click on whichever gamble gave him or her the best chance of receiving the least amount of pain. Participants were given ten seconds to make a decision, otherwise a gamble would be randomly chosen for them. The arrow spun for three seconds eventually landing on a colored sector. They were subsequently given five seconds to internalize their decision and compare their outcome to the alternative outcome. Each trial was separated by a one second fixation screen. After each trial, we randomly selected one of four skin spots on the forearm to induce the temperature. The researcher would then manually stimulate the randomly selected skin spot (Figure 2) using the Medoc Pathway thermal stimulation system. The main incentive and motivator of this experiment is to avoid receiving high levels of thermal stimulation. The participant then ranked the pain during the induction through an on-going pain scale ("How much pain do you feel at this moment"), followed by a scale representing the overall pain the participant felt ("How much pain did you feel overall"). Both scales ranged from 0 ("No Pain Experienced") to 100 ("Most Pain Imaginable"). Participants took part in a total of 60 trials, split in two successive sessions: 30 partial feedbacks and 30 complete feedbacks. The order of the conditions were randomly chosen. At the end of the experiment, each participant was fully debriefed concerning the purposes of the experiment. The psychophysiological responses (SCR

and heart-rate) were triggered to record when the gambles appeared, once a gamble has been chosen and they saw their outcome, and before pain induction.

Figure 2. *Pain Induction Sites*



Physiological Measures

Skin Conductance measurement and preprocessing - Skin conductance was recorded by MP150 BIOPAC recorded at 500 Hertz (Hz) using the EDA100C-MRI hardware. The data was down-sampled to 1 Hz for further analysis. The two sensor nodes were placed on each participants' middle and ring fingers while the Heart-Rate sensor was placed on the index finger.

Facial Expressions measurement and preprocessing - The face of each participant was recorded by the FaceSync (Cheong, Sawyer, & Chang, In Prep) facial expression recording setup using head-mounted GoPro Hero 4 camera at 720p resolution at 120 frames per second. The videos were automatically aligned to the beginning of the stimulus by the FaceSync software (Cheong, Sawyer, & Chang, In Prep). Facial expressions and facial action units were extracted through the Emotient FACET engine on the iMotions software. The data was down-sampled to 30 Hz by averaging.

Experimental Example

Figure 3a. *Partial feedback condition.*

Figure 3b. *Complete feedback condition.*

Figure 3a displays the partial feedback condition. In this case, the left gamble shows a higher disappointment value. Since $P(A_{disp}) = |48 - 44| - |47 - 45| = 2$, if you're anticipating disappointment, you'll chose the right gamble in order to minimize disappointment.

Figure 3b displays the complete feedback condition. Both gambles exhibit the same degree of regret. $P(A_{reg}) = |48 - 45| - |47 - 44| = 0$. Finding the differences between each gamble's best outcome and the alternative gamble's worst outcome shows the degree of regret for each trial.

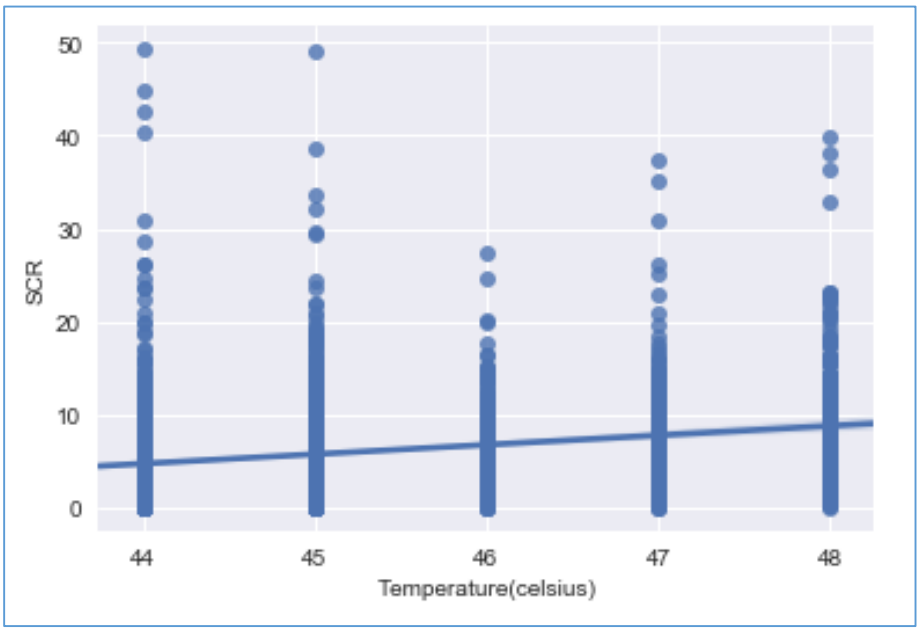
Results 1

Manipulation check

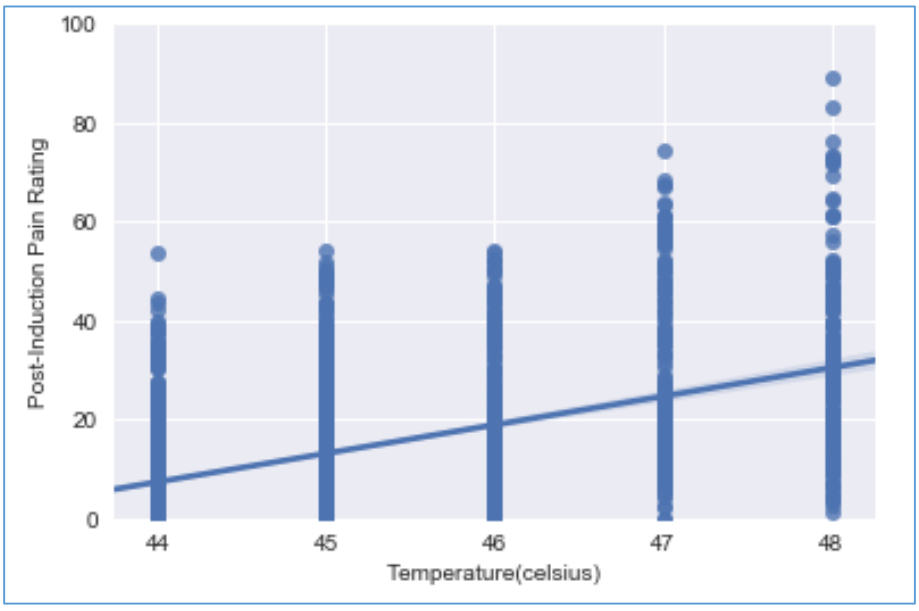
First we checked if the thermal stimulations produced aversive pain on our subjects. Comparing our low temperatures (44°C) vs our high temperatures (48°C), subjects exhibit an increase in skin conductance correlated ($p > 0.001$) to temperature (Graph 1). The on-going and post-induction ratings provide further evidence for the different levels of pain felt from the induction

of low temperature versus high temperature. This is seen through participants' higher average for pain-rating in relation to temperature (Graph 2). The manipulation check allows us to confirm that our manipulated variables of temperature did indeed induce an impact on the subjects.

Graph 1. *Skin Conductance Response(SCR) vs Temperature*



Graph 2. *Temperature vs Post-Induction Pain Rating*
The graph displays participants' average pain-rating for each temperature on a self-reporting scale of 1-100.



Replicating the effect of anticipated regret and disappointment on choices

Regret, disappointment, and expected value exist as the three predictors that lead to a subject's choice of gamble. Applying the same logistic model used in Coricelli et al (2005), we see an effect for expected value and anticipated disappointment, however no sign of an anticipated regret. The results depict participants' choice behavior only in the complete feedback condition.

Table 1. *Regression Analysis of Experiment 1*
Through the complete feedback condition, the table shows subjects' choice as a function of expected value (*e*), disappointment (*d*), and regret (*r*).

	Coefficients	Std. error	Z-score	P-value
Constant	0.216	0.095	2.267	0.023
Expected Value (*e*)	1.071	0.086	12.498	<2e-16
Disappointment (*d*)	0.776	0.090	8.642	<2e-16
Regret (*r*)	-0.002	0.070	-0.025	0.980

We used mixed effect analysis to account for individual differences between each trial, thus allowing us to measure each of the thirty choices of one subject independently. The model shows regret's correlation was the only insignificant predictor ($p = 0.9802$). While subjects primarily considered expected value ($p < .001$), they also used disappointment ($p < .001$) in their thought-process. According to our equations, disappointment is defined as the difference in absolute value of the highest outcome and the lowest outcome within each gamble. Thus participants chose decisions based on comparing inner-gamble outcomes. In this complete feedback condition, subjects could observe the unattained outcome as well as obtained outcome. However, despite the risk of feeling regret, subjects pursued maximizing expected value and avoiding future disappointment rather than avoiding regret.

The effect of anticipated regret on decision-making over time

Coricelli et al (2005) suggests the effects of anticipated regret increases over time in the decision-making process. We tested another model using regret and trial interactions to see the significance of anticipated regret over the course of the experiment. The results show that anticipated regret is significant with trial interaction ($p = 0.0294$), which suggests that people increasingly made decisions based on anticipating regret as the experiment progressed.

Table 2. *Regression Analysis of Experiment 1 with trial interaction.*
In the complete feedback condition, table shows the significance of anticipated regret taking into factor trial progression.

	Coefficients	Std. error	Z-score	P-value
Constant	0.330	0.144	2.290	0.022
Expected Value (*e*)	1.563	0.246	6.356	2.07e-10
Disappointment (*d*)	1.191	0.219	5.444	5.22e-08
Regret + Trial	-0.029	0.223	-0.130	0.0896

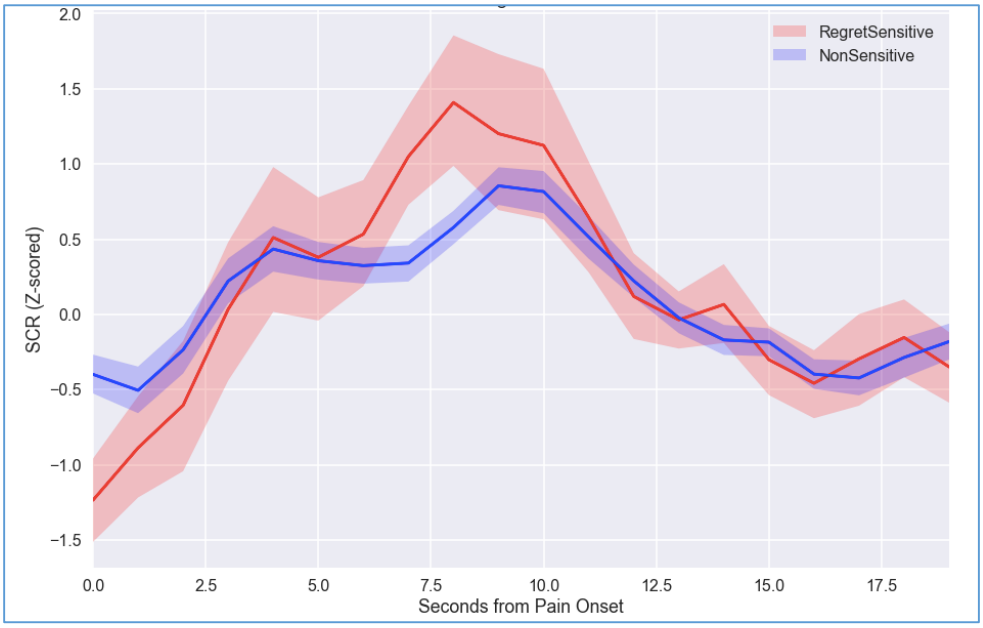
Psychophysiological analysis of anticipated regret

Running the same model for each person separately, we found 12 participants with regret parameter significant at level 0.10. Thus, we restricted our psychophysiological analysis to those 12 participants who showed significant use of the regret decision variable ($p < 0.10$). We then compare the SCR and heart-rate of these 12 regret-sensitive (RS) participants with all the regret - insensitive (RIS) participants.

Comparing Regret-Sensitive to Regret-Insensitive Subjects on Regret Trials

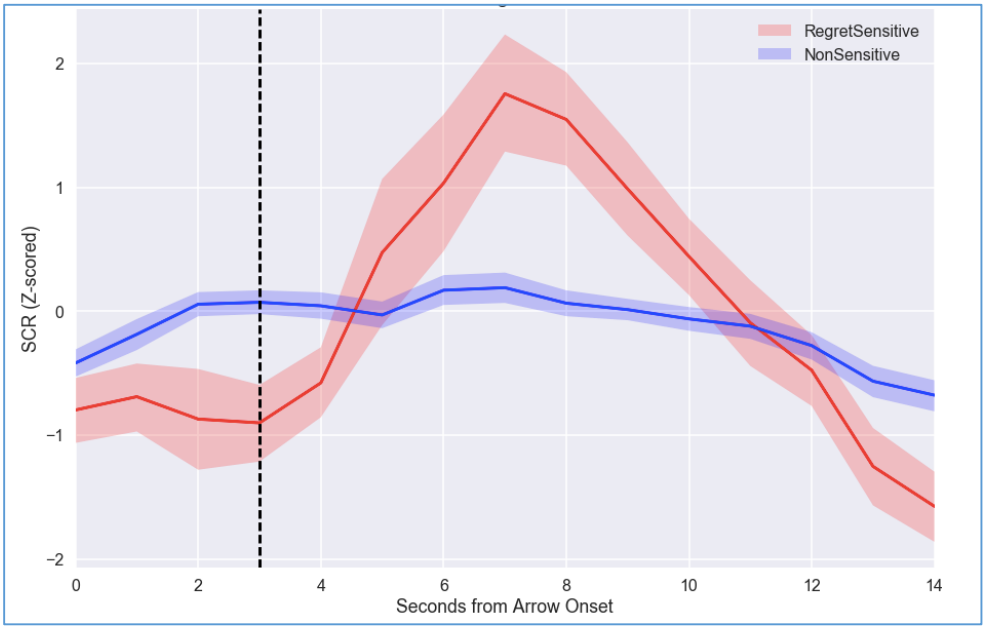
SCR and HR were recorded at three points of each trial. Induction (3a) - during thermal stimulation induction. Regret Onset (3b) - when participants decide on a gamble, subsequently seeing the arrow spin and the outcome. Cue (3c) - when participants see their choices. The three graphs compare regret-sensitive and regret-insensitive participants at these three moments.

Graph 3a. *Induction: Regret Effect on SCR*

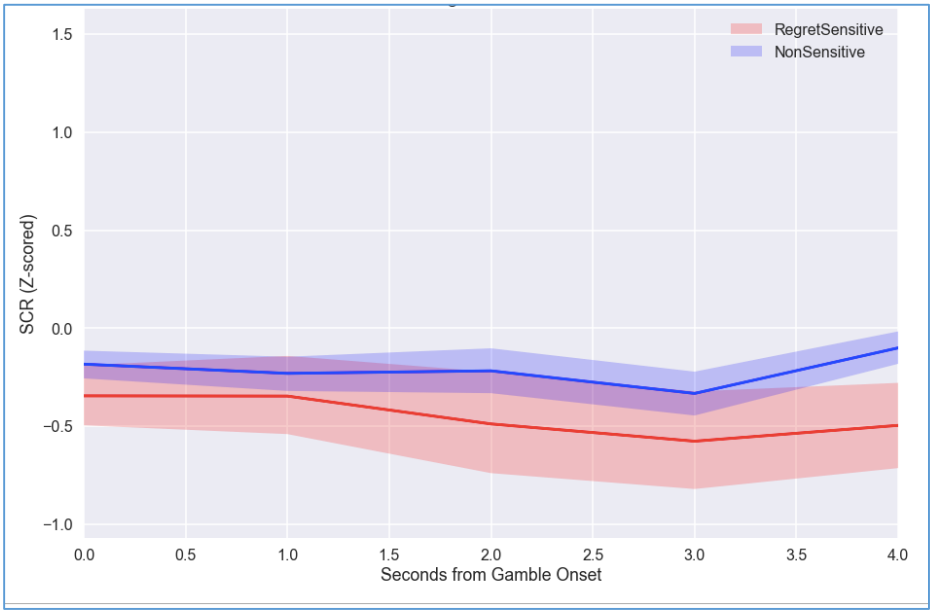


Graph 3b. *Result Onset: Regret Effect on SCR*

Participants make choices at the 3 second mark, subsequently seeing the arrow spin for 4 seconds and the outcome for the last 7 seconds.



Graph 3c. *Cue: Regret Effect on SCR*



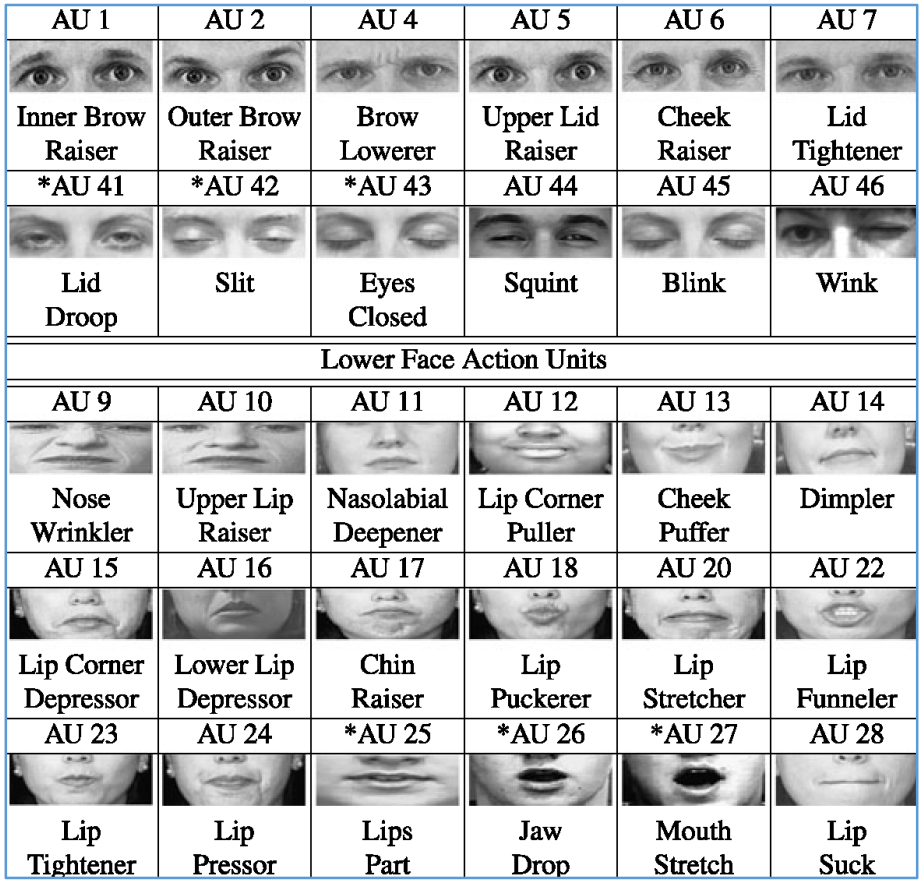
The psychophysiological signatures of regret are highly apparent through the regret-sensitive participants. RS participants had elevated SCR responses (Graph 3b) when witnessing a regret inducing result. This indicates that participants who consider regret in their decisions, are the same people who subsequently get aroused in seeing the alternative outcome. This may result in RS participants experiencing regret more severely (Graph 3a) than those who don't consider regret from the beginning. In regards to heart-rate, no significant differences were found between RS and RIS participants.

Facial expression analysis

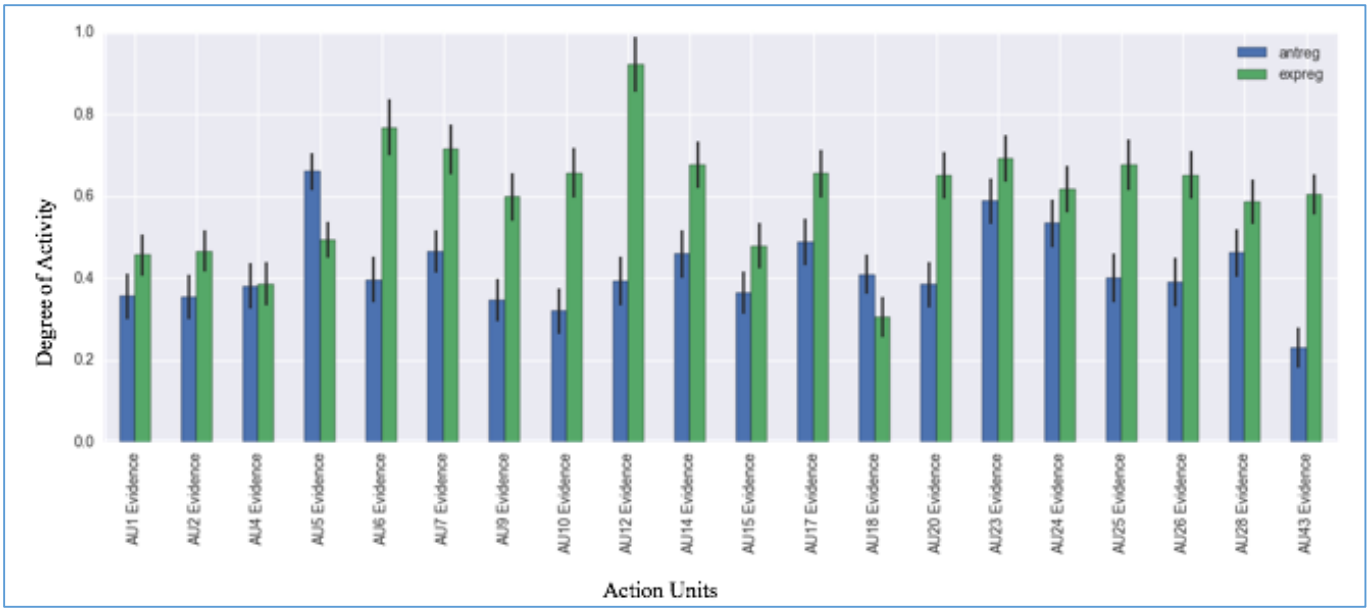
The facial expressions of anticipated and experienced regret are extracted and subsequently examined through the degree of activity for specific facial action units. Action units represent each observable component of facial movement. Anticipated regret faces are extracted from the maximum activity of action units during the five-second period from when participants were

presented with the two gambles. These participants are comprised of participants who used anticipated regret as a decision variable in hopes of avoiding regret. Experienced regret faces are extracted from participants after the spin has landed on an outcome in the complete feedback condition. Only participants who had outcomes that are worse than the outcome they had forgone are considered for experienced regret. Similar to anticipated regret, experienced regret expressions are grabbed through the maximum degree of activity for specific facial action units over a five-second period post-outcome. We examine 20 action units that each describe specific muscle movements that are linked to relative facial patterns (Figure 4). The degree of activity for each action unit is then compared between anticipated and experienced regret.

Figure 4. *Action units representing facial patterns*
Each of the 20 action units we tested represent a specific facial pattern. We use this chart to differentiate the facial patterns that are attributed to anticipated and experienced regret.



Graph 4. *Action unit activity of anticipated and experienced regret for Experiment 1*
The bar graph shows the level of activity of 20 facial action units. Anticipated regret (blue) and experienced regret (green) are compared for each of the 20 action units.



The action unit variables must be statistically significant taking into factor all 20 action units. Thus, we use Bonferroni's correction to determine a statistically significant correlation coefficient.

Bonferroni correction = statistically significant p-value / number of dependent variable

Bonferroni correction = 0.05/20 = 0.002

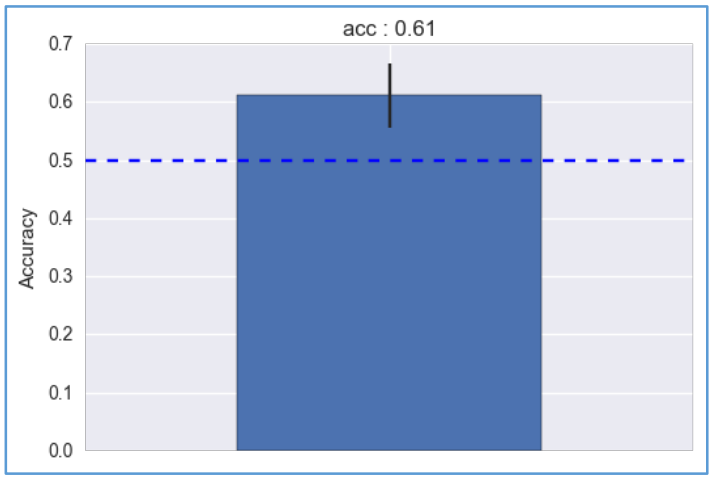
Table 3*. Action Unit significance relative to experienced regret*
The table shows each adjusted p-value and the associated facial pattern.

Action Unit	*T* - value	*P - value*	Facial Pattern
AU1 Evidence	1.32	0.1878	Inner Brow Raiser
AU2 Evidence	1.55	0.12164	Outer Brow Raiser
AU4 Evidence	0.07	0.94496	Brow Lowerer
AU5 Evidence	-3.22	**0.00134**	**Upper Lid Raiser**
AU6 Evidence	3.57	**0.00037**	**Cheek Raiser**

AU7 Evidence	3.01	0.0027	Lid Tightener
AU9 Evidence	3.06	**0.00229**	**Nose Wrinkler**
AU10 Evidence	3.84	**0.00014**	**Upper Lip Raiser**
AU12 Evidence	5.01	**0.0**	**Lip Corner Puller**
AU14 Evidence	2.47	0.01383	Dimpler
AU15 Evidence	1.51	0.13263	Lip Corner Depressor
AU17 Evidence	1.88	0.0604	Chin Raiser
AU18 Evidence	-1.71	0.08764	Lip Puckerer
AU20 Evidence	3.18	**0.00156**	**Lip stretcher**
AU23 Evidence	1.24	0.21593	Lip Tightener
AU24 Evidence	0.96	0.33986	Lip Pressor
AU25 Evidence	2.81	0.0051	Lips Part
AU26 Evidence	2.93	0.00353	Jaw Drop
AU28 Evidence	1.49	0.13547	Lip Suck
AU43 Evidence	6.03	**0.0**	**Eyes closed**

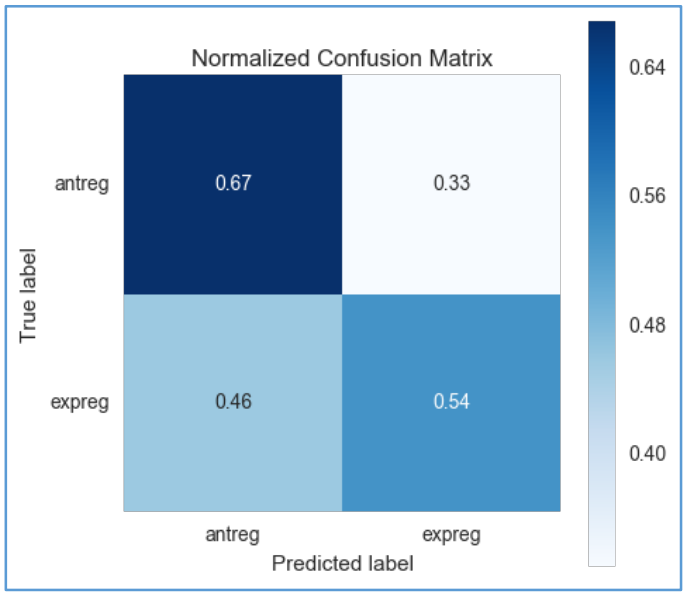
Examining our most statistically significant facial patterns, we see that experienced regret has a higher degree of activity in action units than anticipated regret in the following facial patterns: Raising of the cheek, raising of the upper lip, lowering of the upper lid, nose wrinkling, corner lip pulling, corner lip stretching, and close of the eyes. We run a logistic regression model in order to test the classification accuracy between anticipated regret and experienced regret. The regression model allows us to estimate the probability of our action units representing one of the categorical dependent variables (experienced regret face vs anticipated regret face). The model can distinguish between the two facial expressions with an accuracy of 61% (Graph 5).

Graph 5. *Logistic regression model showing classification accuracy for Experiment 1*



Furthermore, we test the accuracy of our classifier model using a confusion matrix (Matrix 1). The matrix shows a higher prediction rate for anticipated regret (67%), than it does for experienced regret (46%). This result may suggest that experienced regret faces have a greater variance in facial patterns than anticipated regret.

Matrix 1. *Confusion matrix showing accuracy of classification model*
The matrix shows the accuracy of the classification model by using the action units to determine if it can correctly categorize between anticipated and experienced regret. The x-axis represents the predicted values and y-axis represents the true values. The average of the two true values (bottom-right corner & top-left corner) depicts the accuracy of the classifier model.



Discussion 1

The results show a lack of regret effects within Experiment 1. Coricelli concluded his participants based their decision making on maximizing expected value and minimizing future regret. While Experiment 1's results also suggest participants' primary decision variable remained expected value, they often disregarded regret and instead used disappointment. However, participants did increasingly use regret as the experiment progressed in agreement with Coricelli's results. In addition, some subjects actually utilized regret as a decision variable. These subjects also had physiological response from the regret-inducing situations. This partial replication of Coricelli's experiment could be due to a number of factors. While Coricelli's participants completed a total of 192 trials of the experimental task. Participants in Experiment 1 were limited to only 60 due to time restrictions and IRB constraints of over-stimulating participants with noxious heat. Despite having 25 more participants than Coricelli, his experiment still allowed for 480 more trials that were conducted more consecutively. Furthermore, both experiments established the effects of anticipated regret increases over time. As a result, facilitating more consecutive trials may have given participants more time for regret to be reflected before each decision.

The most significant modification of this experiment is obviously the incentive. Instead of aiming to accumulate money, subjects aimed to avoid greater amounts of pain. Each trial ends with "pain", meaning irrespective of a wise gamble, each subject still felt a loss. The experiment's loss domain may have an effect on peoples' choices. Previous research on decisions under risk have shown that individuals are risk-seeking in a loss domain (Kahneman & Tversky, 1979). Subject's risk-seeking behavior could be rationale for finding some relative positive in a situation that always end negatively. Thus, while making decisions under

uncertainty, regret could be insignificant due to the improbability of rejoice. Subjects lost at the end of each trial, even if the subject received a "lesser pain", the thermal induction would not induce a feeling of joy. In a real-world example, imagine you and a friend dined at a restaurant one night and ordered different meals. That night both of you get food poisoning. However, while your symptoms include vomiting, fever, and nausea, your friend's symptoms only consist of fever and nausea. You're most likely not going to regret your meal for your friend's meal because that also ends horribly. Without the possibility of winning, or the ability to feel responsible for a truly favorable outcome, anticipating regret appears trivial without the hope of an objectively positive alternative. Furthermore, this may explain subjects' attempt in minimizing disappointment. Disappointment exclusively focuses on the difference of outcomes in each relative gamble. Choosing the smaller difference may be a way of settling for a relative win in a losing context.

In addition to modifications within the paradigm, assessing the gamble combinations that Coricelli implemented, we came to the conclusion that Coricelli's combinations produce high collinearity between the predictor variables (Table 4). Coricelli applied 5 values and 2 probability outcomes (0.5/0.5 & 0.8/0.2) to structure his gamble combinations, while having multiple repeated combinations. The variance inflation factor (VIF) measures the degree of inflation between estimated regression coefficients. A high VIF can suggest strong correlation between predictors as well as an instable model. Coricelli's experiment produces a VIF of [3.3442, 2.2081, 3.0087] for expected value, disappointment and regret. This relatively high VIF could suggest high multicollinearity within his three predictors. Examining Coricelli's correlation table for his predictor variables, we indeed see strong correlations between regret and expected value (Table 4). The strong correlation between expected value and regret may explain

Coricelli's participants using regret and expected value as their main decision variables. While constructing Experiment 1's gamble combinations, we took a conservative measure to assure a low VIF value of [1.1180, 1.1202, 1.0685]. The weak correlations from Experiment 1's predictor variables (Table 5) allows for a valid regression, allowing participants to properly differentiate expected value and regret as their main decision variables. Contrasting VIF values, combined with the use of redundant items, further explains Coricelli's regret finding

Table 4. *Coricelli's correlation table of predictor variables*

	Expected Value	Disappointment	Regret
Expected Value	1.000	0.395	0.619
Disappointment	0.395	1.000	-0.249
Regret	0.617	-0.249	1.000

Table 5. *Experiment 1's correlation table of predictor variables*

	Expected Value	Disappointment	Regret
Expected Value	1.000	0.260	0.151
Disappointment	0.260	1.000	-0.157
Regret	0.151	-0.157	1.000

Recording the psychophysiological responses of regret showed minimal physiological responses for majority of the participants. This could be a result of a "pain" that was not painful enough. Consequently, this may have precluded participants from feeling regret or even consider the implications of their decisions. However, the 12 participants who used regret as their main decision variable, showed elevated SCR responses after their decisions (Graph 3b). Our study

can't explain the psychophysiological response by differentiating the regret effects with temperature sensitivity. Though the physiological responses may be due to anticipating regret, it is more likely that these participants are simply extra sensitive to temperature and nervous of the thermal pain.

The facial expression analysis resulted in regretful moments being associated with consistently more activity in action units than faces where decisions are made based on anticipated regret. Despite this finding, anticipated and experienced regret are only 61% (Graph 5) distinguishable using a logistical regression. Though more than a 50/50 chance of differentiating between the two feelings, they remain indistinct. The lack of extracting consistent facial expressions for anticipated regret further supports earlier results of participants' failure in using regret in the gambling task. However, this leads to the idea that anticipated regret may actually transpire through subtle cognitive processing without distinctive facial patterns. While experienced regret has more dynamic facial patterns, it is even less accurate to predict (Matrix 1). This is a product of the variance in experienced regret facial expressions that could be due to other factors such as temperature sensitivity. Thus, Experiment 1's pain paradigm shows a lack of evidence for distinctive facial features of anticipated and experienced regret.

In summary, participants in a loss domain primarily used expected value and disappointment as their decision variables. Context seems to play a major role in considering regret. While Coricelli's experiment had the opportunity for an alternative positive outcome, Experiment 1 was conducted through purely negative outcomes that may have consequently resulted in participants not anticipating regret. Furthermore, regret increases with an increase in frequently consecutive decision-tasks. Limitations within our trials may have precluded the feeling of regret from ever arising. This was evident in the psychophysiological responses and

facial expression analysis as majority of participants showed no true signs of anticipated and experienced regret. My hypothesis of anticipated regret having an impact on decision-making was incorrect due to the lack of consideration for the emotion, as well as the absence of any significant psychophysiological responses. Though consistent facial patterns of anticipated regret were predictable, this was more likely due to an inconsistent absence of expressions than an actual existence of expressions. After seeing the effects of anticipated regret on decision-making using pain avoidance as the incentive, we test these same effects in Experiment 2 using monetary values as our main incentive.

Experiment 2

Experiment 2 tests the same hypothesis as Experiment 1 in the hopes of investigating the effects of anticipated regret on decision-making. We'll examine the effects through participants' psychophysiological responses in relation to their specific decision variables. Similar to Experiment 1, participants always lost at the end of each trial. The monetary paradigm conduction under a loss domain allows for direct comparison between pain and monetary incentives. Exploring the consistency of anticipated regret through multiple incentives further solidifies the validity of the complex emotion.

Methods 2

Subjects

Forty healthy subjects completed the experiment (29 males and 11 females, mean age = 20.8, standard deviation = 1.0). All subjects attended Dartmouth College, and were recruited through an online posting and various social media outlets. Subjects were paid $10 for their participation,

and had the chance to win an additional $8. Two facial recordings were unused in the analysis due to improper video synching and loss of data. Each participant provided informed consent before beginning the experiment. The experiment was approved by the Institutional Review Board (IRB) of Dartmouth College, and funded by a grant from the office of Undergraduate Research of Dartmouth College.

Experiment Paradigm

Participants were given two choices of gambles. Each gamble had two outcomes with manipulated probabilities and amounts of money they could risk losing. The probability of each outcome was depicted by a colored area of the circle. Following instructions and questions, participants repeatedly picked one of two gambles designed with a set of monetary losses [-2$, -4$, -6$, -8$, -10$] paired with probability values [.9/.1; .7/.3; .5/.5]. Clearly, the smaller the value meant the larger the monetary payout that the participant received. At the beginning of each trial, two gambles are displayed on the computer screen. The participant used the mouse to click on whichever gamble would give him or her the best chance of retaining the most amount of money. Participants were given ten seconds to make a decision, otherwise a gamble would be randomly chosen for them. The arrow spun for three seconds before landing on a colored sector. The participant was subsequently given five seconds to internalize their decision and compare their outcome to alternative outcomes. Each trial was separated by a one second fixation screen. At the beginning of the experiment, $10 was handed to each participant to assure them their monetary gain. The main incentive and motivator of this experiment is to retain as much of their $10 as possible. After each trial, the participant would rank their level of satisfaction (“How much pain do you feel at this moment”), on a scale ranging from 0 (“Extremely disappointed”) to

100 ("Extremely Satisfied"). Participants took part in a total of 60 trials, split in two successive sessions: 30 partial feedbacks and 30 complete feedbacks. The order of the conditions were randomly chosen. At the end of the experiment, each participant was fully debriefed concerning the purposes of the experiment. The psychophysiological responses (SCR and heart-rate) were triggered to record when the gambles appeared, once a gamble has been chosen and the arrows are spinning, and after the arrows land on an outcome showing the gamble results.

Physiological Monitoring

Skin Conductance and Facial Expressions measuring and preprocessing were both done through the same method as Experiment 1.

Results 2

Replicating the effect of anticipated regret and disappointment on choices

Regret, expected value, and disappointment are the three decisions variable tested for significance. Using a logistic regression model, expected value exists as the only significant decision variable used by subjects in their choice of gamble.

Table 6. *Regression Analysis of Experiment 2*
Through the complete feedback condition, the table shows subjects' choice as a function of expected value (*e*), disappointment (*d*), and regret (*r*).

	Coefficients	Std. error	Z-score	P-value
Constant	0.167	0.124	1.344	0.179
Expected Value (*e*)	2.711	0.223	12.133	2e-16
Disappointment (*d*)	-0.125	0.148	-0.842	0.400
Regret (*r*)	-0.372	0.061	-6.068	1.29e-09

Using mixed effect analysis in the regression model allows us to account for individual differences and measure each of the subjects' choices independently. The model shows disappointment as the only insignificant decision variable ($p = 0.400$). While participants used expected value ($p > .001$) in their choices, regret had a significantly negative correlation (-0.37180) with participants' choices. Meaning, according to our equations, participants chose gambles in search of the biggest differences between inter-gamble choices. Thus, participants chose riskier gambles in this paradigm. Despite the ability to observe their alternative outcomes (complete feedback condition), participants were consistently risk-seeking in this domain.

The effect of anticipated regret on decision-making over time

Comparing Coricelli et al (2005) findings that regret increases over time, we test our model to see if any relationship between regret and time exists within our monetary paradigm. Running the model to consider trial progression along with regret, we can see the effects of anticipating regret as the experiment progressed. Taking into factor that participants' anticipation of regret is negatively correlated in their choices (Table 6), they should technically use less regret over time if a strong correlation between regret and trial progression exists. However, unlike Coricelli's findings, participants' use of regret as a decision variable does not increase (or decrease in our case) throughout Experiment 2.

Table 7. *Regression Analysis of Experiment 2 with trial interaction.*
In the complete feedback condition, table shows the significance of anticipated regret taking into factor trial progression.

	Coefficients	Std. error	Z-score	P-value
Constant	1.683	0.193	8.712	< 2e-16
Expected Value (*e*)	3.692	0.339	10.895	< 2e-16
Disappointment (*d*)	-0.178	0.191	-0.929	0.353
Regret + Trial	-1.160	0.194	-5.973	2.33E-09

Psychophysiological analysis of anticipated regret

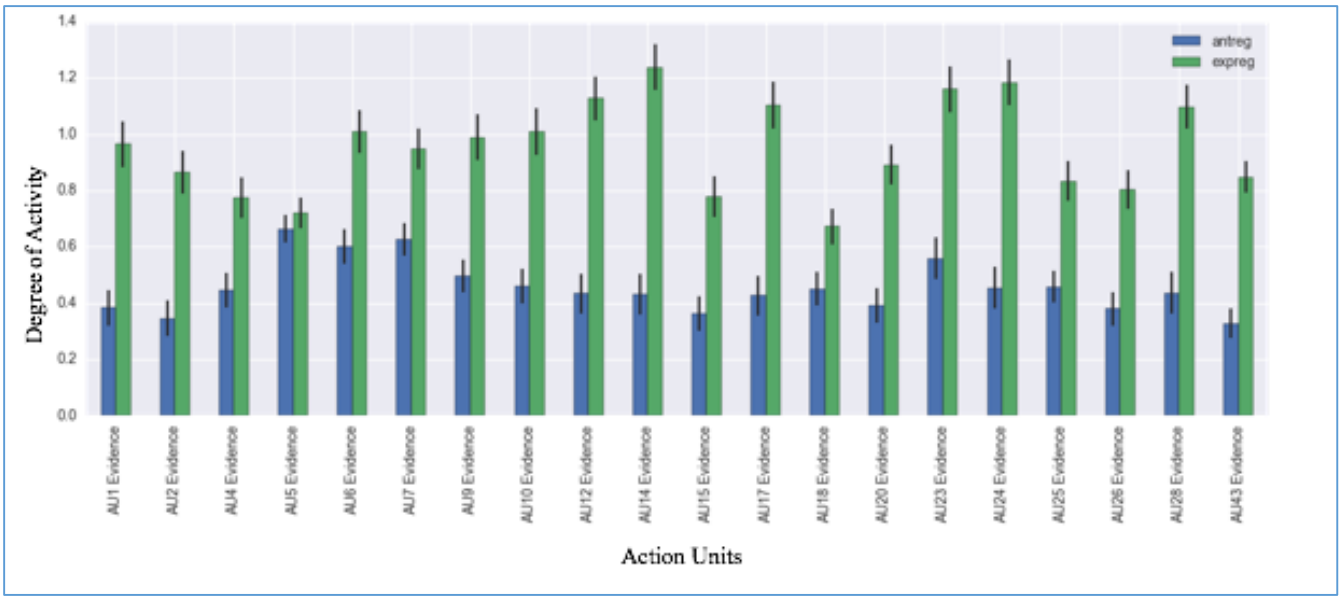
The regression analysis showed that regret was not used in participants' decision-making process (Table 6). Instead, participants' choices actually had a negative correlation with regret (-0.37180). Assuming participants would not purposely seek regretful decisions, their choices most likely did not require them to anticipate regret. As a result, participants in Experiment 2 had no signs of psychophysiological signs of anticipated regret.

Facial expression analysis

Facial expressions are analyzed through the degree of activity of specific facial action units. Anticipated regret faces are extracted from the maximum action units during the 5 second period from when participants were presented with the two gamble choices. Similar to anticipated regret faces, experienced regret faces are extracted over a 5 second window post-decision, where the maximum degree of facial action units are recorded. Anticipated regret faces are focused on participants who generally made gamble choices consistent with

minimizing regret. Experienced regret faces occur with participants that obtained outcomes worse than the forgone outcome. We examined 20 facial action units representing specific muscle movements. The degree of activity for each action unit is compared between anticipated and experienced regret.

Graph 6. *Action unit activity of anticipated and experienced regret for Experiment 2*



Bonferroni correction allows us to determine a statistically significant correlation coefficient for the 20 action unit variables.

Bonferroni correction = 0.05/20 = 0.0025

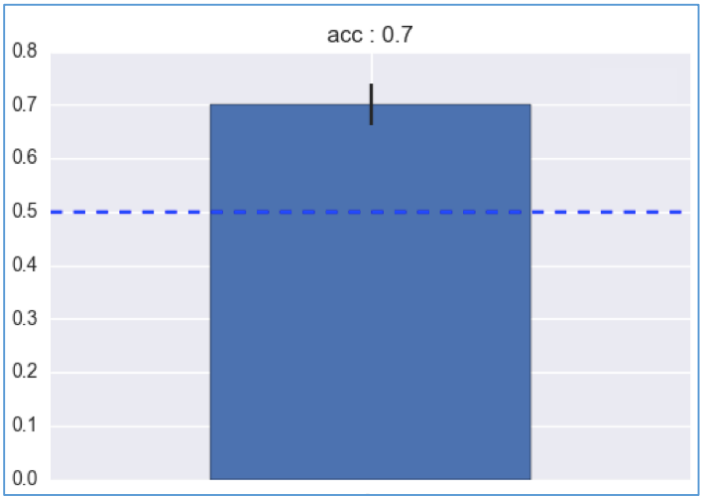
Table 8. *Action Units significance for Experiment 2*

Action Unit	Coefficient	*P - value*	Facial Pattern
AU1 Evidence	5.45	**0.0**	**Inner Brow Raiser**
AU2 Evidence	5.61	**0.0**	**Outer Brow Raiser**
AU4 Evidence	3.42	**0.00069**	**Brow Lowerer**
AU5 Evidence	1.48	0.13842	Upper Lid Raiser

AU6 Evidence	4.3	**2e-05**	**Cheek Raiser**
AU7 Evidence	3.65	**0.0003**	**Lid Tightener**
AU9 Evidence	4.8	**0.0**	**Nose Wrinkler**
AU10 Evidence	5.14	**0.0**	**Upper Lip Raiser**
AU12 Evidence	6.53	**0.0**	**Lip Corner Puller**
AU14 Evidence	7.14	**0.0**	**Dimpler**
AU15 Evidence	4.25	**3e-05**	**Lip Corner Depressor**
AU17 Evidence	5.52	**0.0**	**Chin Raiser**
AU18 Evidence	3.09	**0.00215**	**Lip Puckerer**
AU20 Evidence	5.33	**0.0**	**Lip stretcher**
AU23 Evidence	5.24	**0.0**	**Lip Tightener**
AU24 Evidence	6.39	**0.0**	**Lip Pressor**
AU25 Evidence	4.93	**0.0**	**Lips Part**
AU26 Evidence	5.56	**0.0**	**Jaw Drop**
AU28 Evidence	5.96	**0.0**	**Lip Suck**
AU43 Evidence	9.07	**0.0**	**Eyes closed**

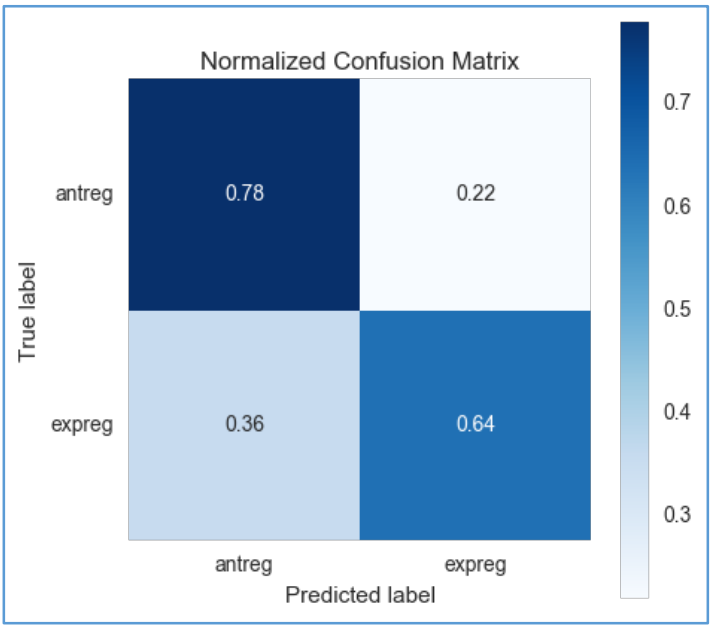
The significance of the 20 action units show experienced regret has a higher degree of activity than anticipated regret for all but action unit 5 (Upper Lid Raiser). Running a logistic regression model shows the classification accuracy between anticipated regret and experienced regret using our action units as a function. The model distinguishes between the two facial expressions with an accuracy of 70% (Graph 7).

***Graph** 7. Logistic regression model showing classification accuracy for Experiment 2*



Furthermore, we test the accuracy of our classifier model using a confusion matrix (Matrix 2). The matrix shows a higher prediction rate for anticipated regret (78%), than it does for experienced regret (36%). This result may suggest that experienced regret faces have a greater variance in facial patterns than anticipated regret in Experiment 2.

***Matrix 2.** Confusion matrix showing accuracy of classification model for Experiment 2.*



Discussion 2

Experiment 2's results display the psychophysiological and decision-making effect of regret when presented with a monetary incentive. Coricelli concluded people made decisions with the goal of minimizing risk and maximizing expected value, taking no significant consideration for disappointment. Participants in Experiment 2 also pursued maximizing expected value, as well as making choices in accordance with regret (Table 6). Thus, while Coricelli's experiment suggests that people avoid regret as a factor in their decision-making, Experiment 2 offers contrary results suggesting participants pursue regret in their decision-making. Assuming participants did not chose gambles explicitly hoping for regret, it is fair to interpret this behavior as risk-seeking.

Coricelli's had 15 participants, each choosing between 192 gambles, and eventually completing a total of 2,880 trials. In Experiment 2, we used 40 subjects who chose between 60 trials and completed a total of 2,400 trials. Coricelli proposes that using regret as a decision variable increases throughout the experiment. Contrary to Coricelli, Experiment 2 suggests no correlation between regret and experiment progression (Table 7). Thus, participants did not become increasingly risk-seeking over time in Experiment 2.

Further differences in the use of regret between Coricelli's experiment and Experiment 2 may be attributed to the context. Experiment 2's gamble choices in a loss domain may nurture risk-seeking behavior (Kahneman & Tversky, 1979). Additionally, participants receive their $10 of gambling money before the beginning of the experiment. Giving the participants a gain before entering the loss domain may actually incentivize them to risk more, known as the *house money effect* (Thaler & Johnson, 1990). While Coricelli also provides monetary gains for participants to gamble, his participants are led to believe they can earn an arbitrary amount of additional gain.

As a result, the vague instructions may lead participants to gamble more cautiously due the, allowing for the anticipation of regret in their decision-making process.

Equally important, we need to take into account the correlation between Coricelli's decision variables. Calculating the variance inflation factor (VIF) shows the degree of inflation between estimated regression coefficients. Coricelli's high VIF of [3.3442, 2.2081, 3.0087] for expected value, disappointment, and regret suggest strong correlation between his variables. Coricelli uses 5 values and 2 probability outcomes (0.5/0.5 & 0.8/0.2) for his combination, inevitably repeating multiple combination in his 192 trials. Further assessing his correlation table, regret and expected value emerge as very strongly correlated (Table 9). Coricelli's participants choosing gambles that minimize regret and maximize expected value is most likely a product of the VIF values. Experiment 2's low VIF of [1.1180, 1.1202, 1.0685] and weak variable correlation (Table 10) brings more legitimacy to our combinations. In Experiment 2, expected value and regret (even if negative) are still correlated to participants' choices.

Table 9. *Coricelli's correlation table of predictor variables*

	Expected Value	Disappointment	Regret
Expected Value	1.000	0.395	0.619
Disappointment	0.395	1.000	-0.249
Regret	0.617	-0.249	1.000

Table 10. *Experiment 1's correlation table of predictor variables*

	Expected Value	Disappointment	Regret
Expected Value	1.000	0.260	0.151
Disappointment	0.260	1.000	-0.157
Regret	0.151	-0.157	1.000

Though our calculations and combinations of the three variables have low correlation (Table 10), participants' heavy preference for expected value may have triggered a deflation of the regret coefficient.

It is possible there exists hidden confounding variables that may influence multicollinearity problems within our experiment. As a result, perhaps regret is not an effective decision variable, or simply doesn't exist in the loss domain. Our psychophysiological responses further questions the existence of regret in the loss domain. No participant used regret as a decision variable, thus there was no significant psychophysiological signatures that could be analyzed to show physiological signs of regret within Experiment 2.

Facial expression analysis comparing anticipated and experienced regret shows experienced regret has more action unit activity in all but one action unit. Thus, excluding upper lid raiser, experienced regret results in higher overall facial muscle activity. While it is likely the finding is confounded with other emotional responses, we can conclude that being able to compare your outcome against the counterfactual does induce instinctive facial responses. Our logistic regression model can distinguish the two emotions with 70% accuracy (Graph 7). However, testing the accuracy of our model exposes the lack of predictability for experienced regret (Matrix 2). Again, this would most likely be a product of more instinctive facial responses that are confounded with experienced regret, thus undermining the model's ability to predict experienced regret accurately. Contrary to experienced regret, anticipated regret is fairly predictable (Matrix 2). However, our participants chose gambles that maximized regret (seeking risk). This suggests the accuracy of predicting anticipated regret is a result of non-variant, subtle cognitive processing and not a result of consistent explicit facial patterns. Experiment 2's facial

expression results further supports the lack of physiological evidence for anticipated and experienced regret.

In conclusion, participants in Experiment 2 chose their gambles according to expected value in a risk-seeking approach. The loss domain of the experiment may have contributed to participants choosing riskier gambles, especially when afforded an external gain due to the *house money effect*. My hypothesis was not supported by the data. I predicted that participants would typically choose gambles that minimize regret in their decision-making process, regardless of domain. The house money effect coupled with a loss domain further incentivizes risk-seeking behavior, bringing to attention that the manner in which choice problems are coded and edited emerge as critical factors in the analysis of decision (Kahneman & Tversky, 1979). Neglecting to use anticipated regret, participants also experienced no psychophysiological arousal, contrary to my predictions. In addition, while anticipated and experienced regret showed distinct differences in level of facial action unit activity, there remains significant inaccuracy of correctly differentiating the two emotions. The facial expression analysis lacks the ability to eliminate any confounding variables that may have contributed to pre and post-decision facial reactions. Experiment 2 generated more questions than answers in regards to the effects of anticipated regret in decision-making. Our inability to obtain results for anticipated regret as a decision-variable, and simultaneously extract psychophysiological responses, could be a result of multicollinearity issues within the experiment. Alternatively, people might not actually anticipate regret in a loss domain since they are already in a regretful context. As a result, regret may not exist in the loss domain in a context that actually encourages risk-seeking behavior. Experiment 2's results will be interesting to compare with Experiment 1, and examine the role of regret in the decision-making process while considering the contributions of context.

General Discussion

Experiments 1 and 2 accomplished similar conclusions through different results, which may be attributed to their differing paradigms. Experiment 1 incentivized participants to choose gambles that led to receiving as little amount of pain as possible. Experiment 2 incentivized participants to choose gambles that lost them the least amount of money. Participants in Experiment 1 did not use anticipated regret while minimizing disappointment in making their decisions. Participants who minimized disappointment chose gambles independently of the alternative gamble. However, participants in Experiment 2 did not use disappointment as a decision variable and instead made decisions suggesting regret maximization which could be interpreted as risk-seeking. In Experiment 2, participants chose in favor of regret in a risk-seeking method that takes both gambles into account. Despite differing result for the use of regret and disappointment, participants in both experiments consistently chose gambles that maximized expected value, suggesting they primarily used rationale over emotion.

Experiments 1 and 2 lead to different results on people anticipating regret throughout the experiment. While Experiment 1 suggests anticipating regret increases with progression of the experiment, Experiment 2 shows no significant relationship between the decision variable and time progression. The most justifiable reasoning for the discrepancies are the use of incentives. Pain is subjective; thus, it can take a few stimulations before recognizing your desire to avoid more stimulations, altering your method of decision-making. Furthermore, visceral factors produce other complications due to their erratic and unpredictable influence on behavior (Loewenstein, 2000), unlike monetary incentives which are easier to calculate. Forecasting how someone would feel is much harder to predict than monetary outcomes. In the monetary

paradigm, the implication of your loss are clear from the beginning of the experiment in a way that does not drive visceral responses. Thus, there is less factors to incite a change in participants' gambling methods in Experiment 2. The difference in incentives most likely contributes to the differences in participants' ability to anticipate regret. Which brings to attention the degree to which the context of Experiments 1 and 2's relative paradigms effect anticipated regret and decision-making.

Both experimental paradigms involve decision-making under a loss domain. Participating in a loss domain cultivates risk-seeking behavior (Kahneman & Tversky, 1979). This is apparent in Experiment 2 as participants consistently chose the riskier gamble in the monetary context. However, in Experiment 1, participants disregard regret while they minimize disappointment. Regardless of choice, the pain paradigm inevitably ended in pain. As a result, no matter how risk-aversive or risk-seeking participants chose to behave, risk exists to some capacity on every gamble choice. Therefore, participants utilizing disappointment may indicate that they are settling for a safer gamble due to the smaller difference within the outcomes of their relative gamble choice. Despite the absence of a visceral factor, Experiment 2 encourages risk-seeking behavior for a different reason. Participants in Experiment 2 have the possibility of walking away with more money than when they walked in. This gives participants in Experiment 2 more reason to be risk-seeking, especially without a negative consumptive experience like Experiment 1. Furthermore, risk-seeking behavior is only exacerbated when considering the *house money effect* (Thaler & Johnson, 1990) and the $10 they receive before beginning their gamble choices. The context of inevitably suffering a pain after every decision, in contrast to simply losing money you never earned, may justify the observation of more risk-seeking behavior in

Experiment 2 than 1. The context of the experimental paradigms may also further contribute to the absence of psychophysiological signatures of regret.

Participants in both experiments showed a lack of anticipating regret. While Experiment 1 resulted in a handful of participants physiologically showing regret-sensitive responses (Graph 3), this may be confounded with temperature sensitivity. The pain paradigm most likely revoked a visceral reaction that contributed to their relative responses. Experiment 2 had no participants anticipating regret (Table 6). Experiment 2's results further demonstrate the potential confounding dynamics of using a pain incentive in Experiment 1. The experiments suggest that anticipated regret may not elicit a bodily response; instead, it may simply be an implicit mental processing condition to assist in decision-making, however does not dictate decision-making.

In addition, the facial analysis shows distinguishing level of facial action unit activity between anticipated and experienced regret. Regardless of paradigm, experienced regret is stimulated through a reaction to observing the outcome after the arrows on the gamble have stopped spinning. Thus, as expected, experienced regret educes more activity for nearly all facial units. Our logistic regression model from both experiments show anticipated regret provokes a more predictable face than experienced regret. As mentioned in the last paragraph, this may be due to the subtle implicit processing that anticipated regret evokes. Unlike anticipated regret, experienced regret is more likely exposed to other confounding emotions since it's based on a reaction. As a result, experienced regret has very low predictably that may be attributed to the high variance in reactional emotions. Thus, while both experiments show distinct levels of facial activity between anticipated and experienced regret, their unpredictability suggest the facial expressions may not adequately exclusively represent anticipated and experienced regret.

Ultimately, both experimental paradigms allow us to examine the effects of regret through multiple lenses. I hypothesized that minimizing anticipated regret will be used in decisions regardless of context, as a result, evoking an increase of psychophysiological responses to distinguish anticipated regret to experienced regret. Both experiments suggest anticipated regret is not a critical factor under loss domains. In fact, the experiments show people actually tend to be more risk-seeking when facing decisions with no possibility of a favorable outcome. All in all, this experiment further displays the ambiguity of regret and shows why its characterized as a complex emotion. Further examination is needed to also check if our paradigm had enough power to detect an anticipated regret response. One way to test this is to change the values to positive and negative monetary values to see if that better exposes the anticipated regret effect. Then we may be able to say that anticipated regret is not significant (or works in the opposite direction) in decision making in loss domains. Future experiments may want to combine the two paradigms by removing the loss domain while continuing to use visceral incentive. Future experiments must remain using the visceral domain while adding a reward component. This paradigm may better demonstrate the effects of anticipated regret by giving participants a visceral hope to win, coupled with the visceral fear of losing. In this proposed experiment, participants could be rewarded with some pleasurable visceral stimuli such as sweet candy, or penalized through some aversive stimuli such as an uncomfortably sour candy. The visceral domain increases the likelihood of provoking the full effects of anticipated regret, while the addition of a reward would allow participants to see an alternative outcome that is truly positive. The experiment's results would better conclude the existence or inexistence of the physiological signatures of anticipating regret and how it effects decision-making.

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Appendix

Experiment 1 Trial Combinations:

44	0.7	48	0.3	45	0.7	47	0.3
44	0.5	48	0.5	45	0.5	47	0.5
45	0.9	48	0.1	46	0.7	47	0.3
44	0.7	48	0.3	45	0.5	47	0.5
44	0.9	48	0.1	45	0.9	46	0.1
44	0.9	48	0.1	44	0.7	46	0.3
44	0.9	48	0.1	45	0.7	47	0.3
45	0.7	48	0.3	44	0.5	47	0.5
44	0.7	48	0.3	45	0.7	46	0.3
46	0.9	48	0.1	45	0.5	48	0.5
45	0.9	46	0.1	46	0.9	47	0.1
44	0.5	45	0.5	44	0.9	48	0.1
44	0.5	47	0.5	44	0.7	48	0.3
44	0.5	45	0.5	44	0.9	47	0.1
45	0.9	46	0.1	46	0.5	47	0.5
46	0.5	47	0.5	45	0.9	48	0.1
44	0.5	46	0.5	44	0.7	47	0.3
45	0.9	46	0.1	44	0.7	48	0.3
44	0.7	45	0.3	45	0.9	47	0.1
44	0.7	46	0.3	44	0.9	47	0.1
44	0.9	48	0.1	45	0.5	46	0.5
45	0.9	47	0.1	45	0.7	46	0.3
44	0.5	48	0.5	45	0.9	47	0.1
44	0.9	48	0.1	45	0.9	47	0.1
44	0.9	48	0.1	44	0.5	46	0.5
45	0.9	48	0.1	45	0.5	46	0.5
46	0.9	47	0.1	45	0.7	46	0.3
45	0.9	48	0.1	46	0.9	47	0.1
44	0.7	48	0.3	45	0.9	47	0.1
45	0.9	47	0.1	45	0.5	46	0.5

Experiment 2 Trial Combinations:

-2	0.7	-10	0.3	-4	0.7	-8	0.3
-2	0.5	-10	0.5	-4	0.5	-8	0.5
-4	0.9	-10	0.1	-6	0.7	-8	0.3
-2	0.7	-10	0.3	-4	0.5	-8	0.5
-2	0.9	-10	0.1	-4	0.9	-6	0.1
-2	0.9	-10	0.1	-2	0.7	-6	0.3
-2	0.9	-10	0.1	-4	0.7	-8	0.3
-4	0.7	-10	0.3	-2	0.5	-8	0.5
-2	0.7	-10	0.3	-4	0.7	-6	0.3
-6	0.9	-10	0.1	-4	0.5	-10	0.5
-4	0.9	-6	0.1	-6	0.9	-8	0.1
-2	0.5	-4	0.5	-2	0.9	-10	0.1
-2	0.5	-8	0.5	-2	0.7	-10	0.3
-2	0.5	-4	0.5	-2	0.9	-8	0.1
-4	0.9	-6	0.1	-6	0.5	-8	0.5
-6	0.5	-8	0.5	-4	0.9	-10	0.1
-2	0.5	-6	0.5	-2	0.7	-8	0.3
-4	0.9	-6	0.1	-2	0.7	-10	0.3
-2	0.7	-4	0.3	-4	0.9	-8	0.1
-2	0.7	-6	0.3	-2	0.9	-8	0.1
-2	0.9	-10	0.1	-4	0.5	-6	0.5
-4	0.9	-8	0.1	-4	0.7	-6	0.3
-2	0.5	-10	0.5	-4	0.9	-8	0.1
-2	0.9	-10	0.1	-4	0.9	-8	0.1
-2	0.9	-10	0.1	-2	0.5	-6	0.5
-4	0.9	-10	0.1	-4	0.5	-6	0.5
-6	0.9	-8	0.1	-4	0.7	-6	0.3
-4	0.9	-10	0.1	-6	0.9	-8	0.1
-2	0.7	-10	0.3	-4	0.9	-8	0.1
-4	0.9	-8	0.1	-4	0.5	-6	0.5