Anger, Fairness and What's in the Brain

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Abstract:

Models of human strategic behavior overlook the importance of emotion for off the equilibrium path behavior. The research reported here uses a simple ultimatum game in a laboratory setting and focuses on patterns of rejections by subjects in different affective states. Subjects' affect is manipulated using photographed images. Subjects then use the strategy method to decide the size of offer they are willing to accept. Results show that affect is important for strategic behavior and that systematic differences arise in what subjects will accept. These results are important for our understanding of behavioral game theory.

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Introduction

I am not a violent person. But, I do have a temper. As Chair of my Department I sometimes get so angry with a colleague that I think am willing to go to any lengths to harm that person. But, I usually walk away, pester my wife with my tale of woe, calm down and do nothing the next day. On reflection I always realize that I was willing to take an action that would not only leave my colleague worse off, but myself as well. Why am I willing to bear such costs, not only for the target of my anger, but also for myself?

Humans are complex beings that come endowed with an emotional system. The limbic system is part of an evolutionarily old system that provides humans (and other animals) with mechanisms to carry out the four F's of behavior: feed, flee, fight and mate. I am going to generically refer to an emotional system, understanding that there are a number of different components to that system. Some portions of the system release hormones in anticipation of a quick response, other parts of the system are crucial for long-term memory and so forth. Where needed I will be more specific.

A number of social scientists have turned to asking what the emotional system might do for the rational, calculating part of human interaction. Some, like Damasio 1994, claim that our emotional system is responsible for our ability to make decisions. That is, rather than spending an infinite amount of time making comparisons across all possible courses of action, our emotional system allows us to use heuristic shortcuts that "feel right." Others like Camerer and colleagues 2005, see human emotion as producing systematic violations of rationality and so provide a basis for correcting standard models of behavior. In this paper I lean more to the latter, pointing out that emotions are an important part of what we are as humans. Those emotions, where they matter, ought to be integrated into our models.

Motivation

In her American Political Science Association Presidential address, Elinor Ostrom called on political scientists to pay closer attention to the ways in which models of human behavior were built (Ostrom 1998). She suggested that while standard models of rationality work well in some domains, in others they fail. She argued that models are critical devices for understanding strategic behavior and for recommending policy change. but, at the same time she cautioned that predictions about policy outcomes are only going to be as good as the models we begin with.

My early work with Lin started with those domains in which strict models of rationality worked well. I was interested in aggregation rules (institutions) and whether changes in rules mattered for outcomes. With an eye toward models and an experimenter's toolkit, I forged ahead, uninterested in instances of failure (usually blaming subject stupidity). I embarked on a study of decision costs with another Workshopper and found myself grinding to a halt. I was observing systematic deviations in behavior under well-defined institutions. Subjects often selected sub-optimal outcomes! Yet I had no models capable of providing explanation. I abandoned the project and began getting interested in bargaining and negotiation games. Here the failures were even more apparent.

At about the same time Lin was forcing us to think about behavioral game theory, I was detouring into evolutionary psychology. Lin, of course, was always a step or two ahead of me, recommending a number of things to read. The combination of behavioral game theory and evolutionary psychology forced me to start thinking about the manner in which the mind is organized and how our emotional systems are related to our behavior.

Many other psychologists, political scientists and economists have been concerned with the role of emotion for behavior. While the 1990s might have been the decade of the brain, the first decade of the 21st century may well be the decade of emotion. In psychology the study of emotion has moved from a being considered a foible of humans and other animals to an important aspect of behavior (see the assorted reviews by Anderson and Bushman 2002, Cacioppo and Gardner 1999, Russell, et al. 2003). In political science the study of emotion has been heavily influenced by Marcus et al. 2000 who focus on the effect of strong emotions for the ways in which information is processed. In economics Frank 1988 led the way, pointing to how emotions might serve as a credible commitment device. If I am so angry that it appears that I cannot control myself and if others can read this as an unambiguous and credible signal, then the question for others becomes whether to fight me or not. That emotions are part of our decision calculus have not been lost on some economists (see Camerer, et al. 2005, Elster 1998, Gifford 2002, Hanoch 2002).

While most studies of emotion, particularly in psychology, focus on attitudinal changes accompanying a stimulus, there is a growing literature concerned with what emotion means for behavior. Many have focused on the relationship between emotion and individual choice, particularly with gambling tasks, time preference discounting and addiction (see the review by Bechara 2004). Others have focused on decision-making with others. For example, Allred, et al. 1997 illustrate ways in which an emotion like anger affects negotiation processes. Anger typically suppresses information processing and retrieval, while at the same time it promotes aggression.

Increasingly economists and neuroscientists have turned to standard games from experimental economics, for which there are well-defined predictions, and used these to examine the effect of emotion. One of the earliest studies to focus on the connection between neural functions and strategic behavior in a simple game is by Sanfey, et al. 2003. Using the ultimatum game, Sanfey et al. 2003 focus on neural differences between fair and unfair offers in the ultimatum game (the discussion in the next section details the ultimatum game). They show, using fMRI, that unfair offers lead to greater brain activation in the bilateral interior insula -- an area commonly associated with negative emotional states (including hunger, thirst, autonomic arousal and pain). At the same time there is a notable activation in the dorsolateral prefrontal cortex. This area of the brain has been linked to cognitive processes such as executive control. Finally they find notable activation in the anterior cingulate cortex, which is implicated in the resolution of conflict between emotion and cognition. The presumption by Sanfey et al. 2003 is that unfair offers trigger a strong emotional response. However, it may be that people respond very differently to unfair offers and there is no control for the emotion that is triggered.

A recent study by Xiao and Houser 2005 also uses the ultimatum game. This study is purely behavioral and the manipulation involves subjects who are allowed to send a costless message back to the person making the offer. Their finding is very robust.

subjects who have an emotional outlet (sending an emotionally charged message) are likely to accept lower offers than those who have no emotional release. From this Xiao and Houser 2005 infer that the emotional substrate is an important part of an individual's decision calculus. Emotions facilitate decision making, although it is not clear which emotions have been triggered nor how they are affecting decisions.

These two studies (and others on decision making) motivate the work here. In this research I isolate a specific emotion, manipulate it and focus on behavioral outcomes. The next section details the experimental design.

Experimental Design

The research design has two components. The first part of the design aims at instantiating a specific emotional state for subjects. The second part of the design then observes the subject's strategic behavior using a standard ultimatum game.

A total of 80 subjects were recruited from college eating areas at Rice University. Three experimental sessions were conducted on different days at the Behavioral Research Laboratory (BRL).

Upon entering the BRL subjects filled out a consent form and then drew an index card. On that card was an identification number and a number indicating the treatment. Subjects were then seated at computer terminals and allowed to use the internet prior to participating in the experiment. This kept discussion to a minimum. Once everyone arrived, the experiment began. Subjects entered information about themselves plus the information on the card that they drew. Once the information was correctly entered, subjects went through a self-paced set of instructions as well as self-paced portions of the experiment.

The experiment had five modules. In the first module subjects were told that they would be facing a memory task. There were then presented 10 picture images that they were to memorize. They were informed that later they would be shown a large number of images and they would be paid $1.00 for each image they correctly remembered and they would lose $.50 for each image they incorrectly recalled. In the second module, an interference task, subjects participated in a risky decision task. Designed by Holt and Laury 2002 this task has subjects choosing among a number of different lotteries in order to determine their risk aversion in a gambling task. The third module had subjects view 40 images, 30 that were new and 10 that they had previously seen. Each image was displayed for 500 milliseconds and then subjects were asked whether they had previously seen the image or not. The fourth module was a one-shot ultimatum game. Subjects were randomly assigned to be proposers or responders. The final module asked subjects a number of personal items through a questionnaire. Once all the modules were run, subjects were paid, in cash, one at a time for their earnings. Earnings were based on their choices in the risk instrument, the number of images they correctly remembered and their allocation in the ultimatum game.

The keys to this experiment involve manipulating the subject's affect (achieved through viewing the images) and observing patterns of rejections in the ultimatum game. As a consequence, this is where the discussion focuses.

Manipulations.

Two manipulations are used in this experiment. Subjects are assigned either to observe "neutral" or "angry" images. The images that subjects view are taken from the International Affective Picture System (IAPS). The IAPS set includes more than 900 stimuli put together to provide common measures for studying emotion and attention. Additional information concerning the IAPS set is found in Lang et al. 1993.

The IAPS data have been calibrated along multiple dimensions. The two dimensions that are of greatest concern for the study of emotion pertain to valence and arousal. Valence concerns positive or negative orientations to the stimulus. Arousal concerns the intensity of affect. High arousal commands attention. Clearly the impact of a stimuli depends both on arousal and valence.

"Neutral" images were drawn from those images clustering around the midpoint on valence and having low arousal. Such images are considered to be "neutral" in that they evoke little affective response. A total of 40 such images were selected. Among the images were mundane household items such as an iron or a chair as well as external objects such as mushrooms or a bus. None of these items had any intrinsic beauty or otherwise

"Angry" images were drawn from pictures that clustered low on valence and high on arousal. Such images are considered to evoke a strong, but distasteful response. Again a total of 40 such images were selected. These images included such things as children toiling in a sweatshop, people pointing guns at the camera and police beating protesters.

Figure 1 shows that there are relatively tight clusters of images across the two dimensions. Subjects always viewed images from the same affective cluster -- in both the memorization task and the memory retrieval task. It was assumed that each experimental manipulation would induce an affective state. Work by Lang, et al. 1993, Davis, et al. 1995 and Smith, et al. 2005 shows that viewing these images induces a clear shift in affect. The affective state typically lasts three to five minutes for a subject.

<Figure 1 About here>

Primary Dependent Variable.

Following the affective primes -- both in with initially viewing images for memorization and then asking for subjects to recall the images they had viewed -- subjects were given instructions for the ultimatum game. The instructions were quite short, subjects were given a simple manipulation check and then they made their decisions. The ultimatum game is a simple game in which one actor, the proposer, is given an endowment and proposes a split of that money with a responder. The latter decides whether to accept or reject the offer. If accepted both parties receive the proposed offer. If rejected, both parties receive nothing.

The ultimatum game is a simple demand game. It is played sequentially, with the proposer taking the first move and the responder taking the second. The game is played under complete information. As such the sub-game perfect equilibrium is simple to calculate. The proposer should offer as little as possible and the responder should accept any non-zero amount. In this sense the proposer takes a maximal share of the amount and the responder is left better off than rejecting the offer and getting nothing.

There is no evidence supporting sub-game perfection. In numerous laboratory settings subjects routinely offer more than the minimum. And that is for good reason as

responders routinely reject non-zero offers. Camerer 2003 notes that among students rejections of 80/20 splits are common, Heinrich et al. 2004 show that cultures vary a great deal in what is deemed acceptable, while Bahry and Wilson 2005 illustrate that what is acceptable is closely tied to social norms.

This experimental design differs from most standard experiments using the ultimatum game. I am uninterested in the offers made by different subject, but only in the range of rejections. As such I use the strategy method for rejections. Each responder details a portfolio of rejections and acceptances for the offers. Once an offer is made it is matched with the subject's choice and that constitutes the decision. Because the focus is with responders, only a single proposer is needed. At the outset of each experiment one subject is randomly selected as the proposer. All of the remaining subjects are made responders. From this pool of responders, one is randomly matched with the proposer. Meanwhile the remaining responders are all matched with the proposer and their payoffs determined in that manner.

Unlike other experiments the proposer was given $20 and asked to allocate it in $1 increments. Responders then had 21 decisions to make, accepting or rejecting each possible allocation.

Simple Hypotheses.

Given these manipulations and the mechanism used, there are two simple hypotheses.

H1: Subjects under the angry and neutral manipulations will choose different rejection portfolios.

The argument stems from the motivation discussion. Anger tends to produce interference in the dorsolateral prefront coretex and the anterior cingular cortex . This in turn confounds social decision making. While in this experiment I am unable to test the neural connections between stimulus and the behavior, I am able to draw inferences about whether an affective state has been induced and whether that in turn is related to the choice of behavioral strategies.

We now turn to a discussion of the results. The focus here is with rejection patterns by responders. As such I exclude the proposer data in order to focus on what people do while anticipating offers.

Results

Before turning to results under the ultimatum game it is important to first check to see if subjects respond to the stimuli. Recall that the memory task was to put subjects into an affective state. Davis et al. 1995 point out that the IAPS images can induce an affective state lasting for several minutes. Of course, this study uses a largely invasive measure technique, requiring either that subjects be placed in a very large magnet or wear a skull cap with a large number of electrodes. Rather than subject subjects to such measurement tools (although I dearly long to do so), a simple emotional inventory was collected from subjects. This inventory covered 11 items, ranging from "interested" to

"afraid" and was designed to measure a fully array of emotional states. The inventory was administered following the ultimatum game. Subjects were asked to rate their feelings for each word. Lower scores indicated that subjects were not in that emotional state, while high scores indicated that the word very much reflected the subject's emotional state.

Figure 2 plots the means on each of the items across the two treatments. These responses are uncorrected for individual differences and as such, pick up the difference across treatments. As can be seen from the figure there are very few differences between the treatments across the emotional states. In most instances the angry treatment results in higher means than the neutral state. However, most of the differences are insignificant. Using a non-parametric test of differences across the distribution of responses (Kruskal-Wallis) each of the emotional responses was tested. The only significant difference ($p < .05$) is with the word "upset." Here subjects in the "angry" manipulation have scores significantly higher than those in the "neutral" condition. This is consistent with what expected from the anger manipulation.

<Figure 2 About Here>

If all of the emotion scores are added together and then normalized using a z-score transformation [N(0,1)] we can see the overall effect of the treatments. A simple ttest finds that those in the anger condition have a significantly higher mean (.18) than those in the neutral condition (-.19). Using a one-tailed test, the difference is significant at the .10 level and in the direction expected ($t=1.60$, $df=72$, $p=.06$). This lends credence to the claim that even though the emotional inventory occurred after the ultimatum game choices, there is an effect brought about by the manipulation. If so, what does this mean for the rejection strategies of subjects?

Ultimatum Game.

The primary task is to determine whether subjects respond differently in what they reject. Rather than hope for asymmetric proposals that might result in rejections, we ask responders to propose an entire profile, anticipating all possible offers. This is known as the “strategy method” (see for example Mitzkewitz and Nagel 1993 or Solnick and Schweitzer 1999). Responders indicate in advance whether they would accept or reject each possible allocation. In the play of the game the experimenter then matches proposers and responders randomly and imposes the outcome.

There are two problems with the strategy method. First, subjects systematically reject “fairer” offers. Oosterbeek et al. 2004, in a meta-analysis of ultimatum games, estimate that rejections are on average 13 percent higher when using the strategy method. Others, however, like Blount 1996 and Brandts and Charness 2000, suggest that the problems are not serious. Whether the procedure raises or lowers the minimal acceptable amount among responders is not of concern here. All subjects were run using the same protocol and as a consequence any differences we observe across subjects is due to treatment effects.

The second problem is of more concern. Studies using the strategy method suggest that subjects may have inconsistent responses as to what they are willing to accept or reject. Typically it is assumed that subjects have a monotonic rejection profile. That is across a range of low offers a subject will reject such an offer. At some point the subject will switching to accepting all subsequent increasing offers. Mitzkewitz and

Nagel 1993 find that most American subjects are monotonic in their behavior (only 10 out of 320 of their observed strategies deviate from this pattern). In contrast, ultimatum games run with Chinese students yield considerable violations of strict monotonicity Hennig-Schmidt, et al. 2002. In the modal set of strategies, subjects reject both low and high offers. Based on videotapes from the experiments, the authors conclude that subjects are using a fairness criterion to justify this deviation from monotonicity. Huck (1999) also reports substantial deviations from monotonic rationality among pupils from a German gymnasium. More than 60 percent of his subjects violate strictly monotonic strategy profiles.[1] With a population sample from Russia, Bahry and Wilson 2005 find substantial violations of monotonicity. In their paper they detail what this means for a concept of fairness and do not see that it is peculiar to the strategy method.

To account for the possibility that subjects unusual strategies under the strategy method, Figures 3a and 3b plot the rejection profiles for each subject. On the vertical axis is whether the subject accepted or rejected the offer. A high value indicates rejecting the offer. The horizontal axis is the share of the offer to the responder ranging from nothing to the full $20. As can be seen from the figures, these subjects respond with consistent, monotonic strategies. Only 5 of 75 subjects "switch" in their rejection profiles, moving from rejecting low offers, to accepting higher offers and then changing to rejecting offers that offer the responder even more. There are another 11 subjects who accept everything that is offered, even if they are offered nothing. The bulk of those subjects (8) are in the angry condition.

<Figures 3a and 3b About Here>

It appears that subjects have considerable heterogeneity in what they think is a minimally acceptable offer. Does this vary with respect to the different treatments? To see this, the percentage accepting each offer is plotted on Figure 4. This figure separately plots those who were in the angry and neutral treatments. The darker bars are those in the angry treatment. What is readily apparent from the figure is that those in the angry condition are more likely to accept lower offers. This continues until an even split and there after there is no discernable difference.

<Figure 4 About Here>

The figure is a bit misleading. The differences between conditions are significant up through an offer of $5 to the responder. Thereafter there is no difference between the two conditions (using a likelihood ratio chi-square test). What the figure does show is that behavior is different in terms of what subjects are willing to initially accept. Given that most subjects are monotonic in their strategy profiles this implies that subjects in the "angry" condition are willing to accept lower offers much sooner than their counterparts in the neutral condition.

In order to measure whether individual choices are related to the treatment condition, a "switching" score was calculated for each individual. This is the point at which the subject chose to move from rejecting the proposal to accepting the proposal. The point at which this switch occurred is coded as a positive integer and can be thought of as the dollar value of the offer to the responder. Responders who accepted everything have a value of zero. The handful of responders who switch twice – rejecting both low

[1] However, subjects participated in four distinct games that allowed very different kinds of responses, so it may be that the play across the games contributed to the odd patterns of rejection and acceptance.

and high offers – are coded for their first switch between rejecting and then accepting an offer.

Not surprisingly, given what is observed from figure 4, there is an effect due to the treatment. Subjects under the anger condition switch, on average, at an offer of 3.53, whereas subjects under the neutral condition switch at an offer of 5.17. Using a standard t-test, this is difference is significant ($t=2.02$, $p=.05$, $df=72$). Likewise, using an assortment of nonparametric tests the same relationship holds (Kruskall-Wallis $c2(1)=4.08$, $p=.04$ and a Mann-Whitney rank sums test $z=2.02$, $p=.04$). Basically the anger manipulation results in subjects accepting lower offers.

Multivariate Tests.

While in the aggregate there are effects due to the treatment, the question is whether this effect is weak, due only to a handful of subjects. Are there systematic variations in the population that might explain these results. For example, are some people (like me) more susceptible to anger? Are they overrepresented in the treatment condition? To try to tease this out several multivariate models were estimated. The dependent variable is the point at which subjects "switched" between accepting and rejecting the offer. Several additional variables were added in order to tease out individual effects. First, the sex of the player was controlled for because it may be the case that there are systematic differences between males and females.. This is coded as a dummy variable with females taking on a value of 1. Another control is the grade point average of the subject. This is the subject's reported GPA and it is included as a rough proxy for understanding the game structure. I also include a control for risk aversion. Using the Holt-Laury gambling task, we have a measure in which a lower score taps risk aversion and a higher score taps risk seeking. It may be that those who are risk seekers are also more susceptible to strong emotions. A variable is also included that measures whether the normalized emotional inventory for the subject. This is the composite measure of the emotion items recorded following the rejection decisions. Finally a dummy variable is included for the treatment condition, with the angry condition taking on a value of 1.

The models are estimated using Tobit, with censoring at the lower bound. The coefficients are reported in Table 1. The first model includes all subjects. There is no effect for the sex of the subject nor for the subject's risk orientation. The normalized emotion scale is in the wrong direction, with higher scores on that measure leading to a larger value when switching. However, the coefficient is noisy, with a large standard error. We do find that a subject's GPA is strongly, and negatively, related to when they switch. Those with a higher GPA are likely to switch more quickly, taking lower offers. Finally, the treatment dummy variable continues to have a strong effect on when subjects switch. The anger manipulation results in subjects accepting lower offers.

<Table 1 About Here>

The second model excludes subjects who failed the manipulation check for the ultimatum game. This results in six subjects being dropped from the analysis, five of whom were in the anger condition. That model, however, shows the same effects. There is no effect for the sex of the subject or their risk orientation. The effect for the normalized emotion inventory decreases compared with the first model. Finally the effect for GPA remains as does the treatment variable effect.

What is clear from these simple multivariate models is that the treatment stands up to individual characteristics. The effect of the angry emotion manipulation holds up.

Implications

It is no surprise that emotions affect behavior. After all, human emotion is a part of our evolved nature. Indeed, emotion is a critical part of how humans (and other animals) navigate daily life. While Damasio 1994 and others claim that emotions allow us to circumvent cognitive gridlock, emotion also serves an important social function. Emotions serve as signals to others about what to expect (recall the four Fs). At the same time emotions systematically affect the ways in which people evaluate information, the ways in which they assign risk to an event and the manner in which they choose among simple strategies.

The findings in this research raise the obvious question of whether "anger" was in fact instantiated for subjects. If so, then this experimental design can easily be replicated in an fMRI environment. This will allow a more precise manipulation of the affective states of subjects, allowing for within subject comparisons. Likewise, if subjects were mildly angered, the central question remains why they were willing to settle for so little? Unlike the results reported by Xiao and Houser 2005, subjects in this experiment did not have an emotional release. Instead they were left in a manipulated affective state with no recourse. It may be that subjects understand that they are relatively powerless in this position -- they do not have first mover rights. Or it may be that what has been elicited in subjects is "fear" rather than "anger." The next study should manipulate other emotions (including happiness and fear) to see if the effects are similar what we find here. As well, the next study should turn to focusing on the proposers rather than the responders. It is likely that anger interacts with the position held by the actors.

On a personal note this research may seem like a far cry from my beginning Workshop days. Why have I wandered from crisp models of human rationality to deal with murky aspects of human cognition and hormones? I lay the blame on Lin Ostrom. While her student she pushed me to not worry about finding a niche within the mainstream of political science. The Workshop put up with my musings and always forced me to defend whatever lame idea I chanced on. Lin always nudged me toward something else that would help me clarify what I was considering. If nothing else she taught me that there was no harm in reading and thinking across many disciplines.

I seriously take Lin's challenge to political science. As political scientists we are fundamentally concerned with institutions that constrain and encourage behavior. As social scientists it is critical that we build our institutions on useful models of human behavior. Where those models fail we should press ourselves. While we made considerable progress as social scientists by adopting stylized models of rationality, merging those models with findings in cognitive neuroscience will make the next steps.

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Table 1. Tobit Regressions censored at 0. The dependent variable is the point at which a subject switched from rejecting to accepting an offer. Standard Errors are in parantheses.

	Model 1	Model 2
Constant	15.34*** (4.42)	15.99*** (4.56)
Sex (0=male, 1=female)	.91 (.93)	.50 (.98)
Risk Orientation	-.28 (.34)	-.19 (.36)
Emotional Inventory N(0,1)	.67 (.48)	.31 (.53)
GPA	-2.78** (1.21)	-2.99** (1.28)
Treatment (0=neutral 1=angry)	-2.30** (.92)	-2.30** (.95)
N	74	68
Psuedo r2	.03	.03

Note: ***p<.01, **p<.05, *p<.10.

Figure 1. Subset of figures used in experiment plotted by arousal and valence. Circles represent neutral stimuli and triangles represent angry stimuli.

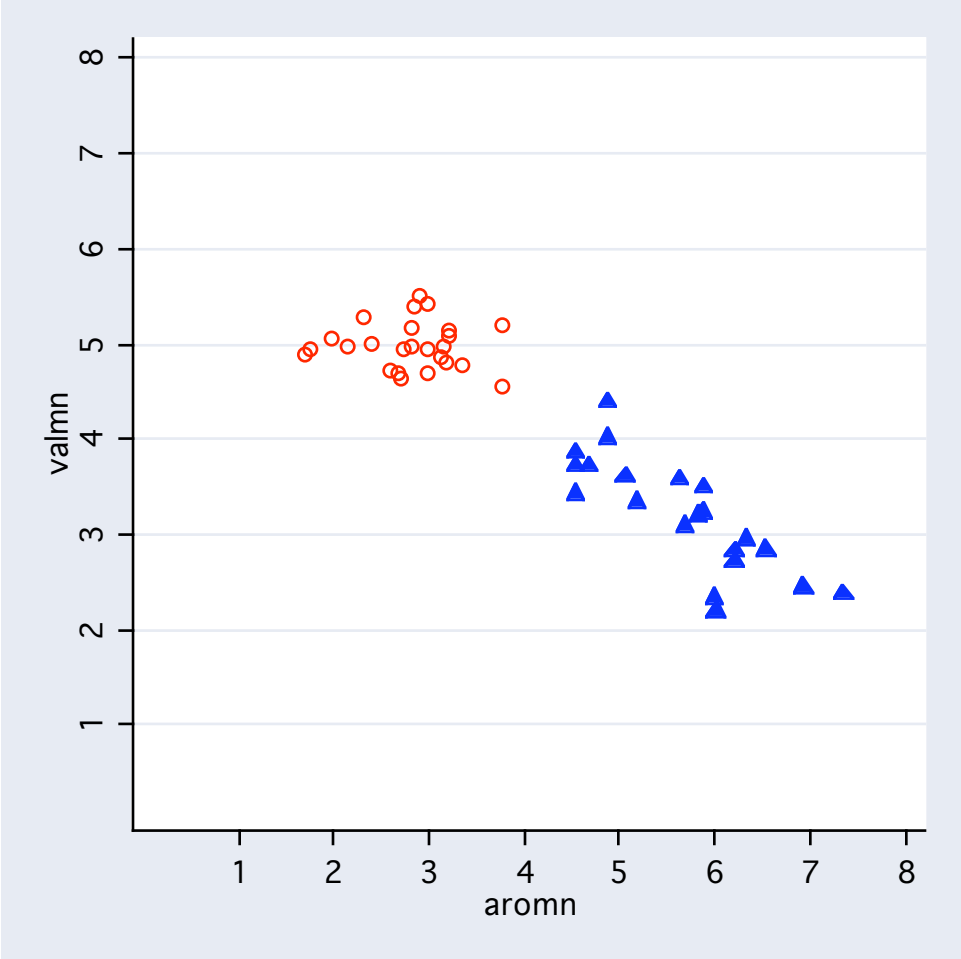

Figure 2. Plot of means for emotional responses by experimental condition.

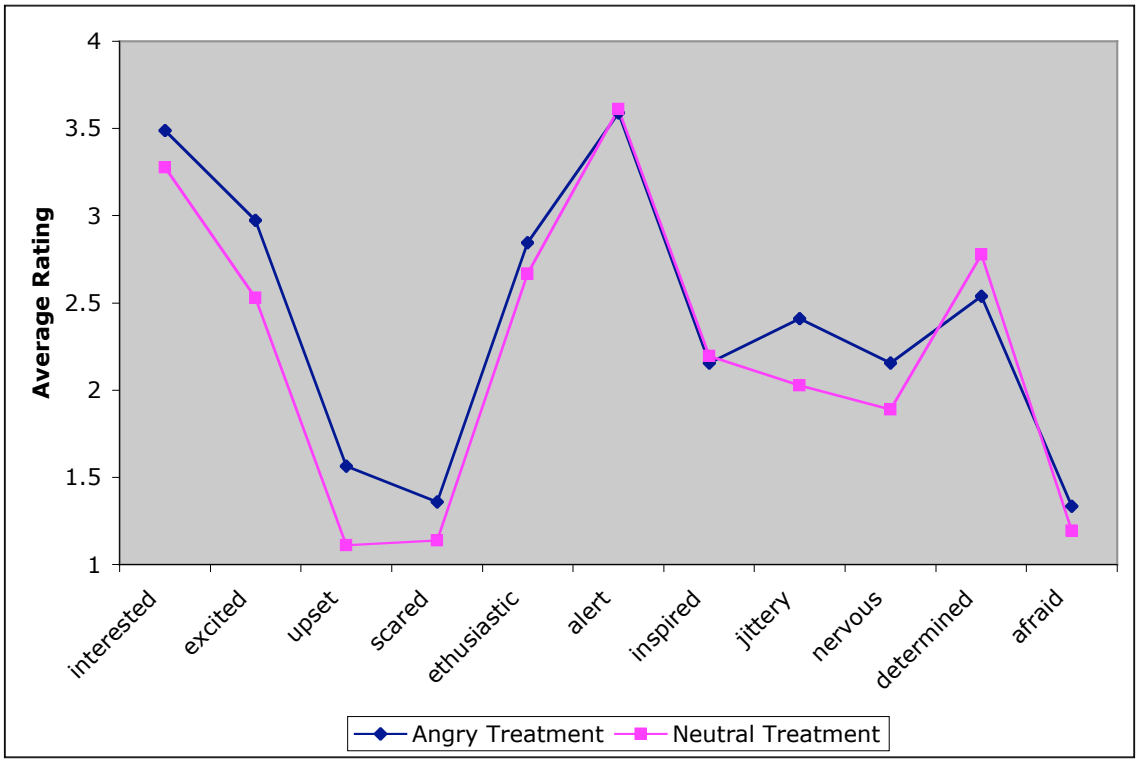

Figure 3a. Rejection profiles for the "angry" manipulation. The vertical axis reflects whether the subject choose to reject or accept an allocation. The horizontal axis constitutes the offer to the responder, ranging from $0 to $20. Each subject's profile is plotted.

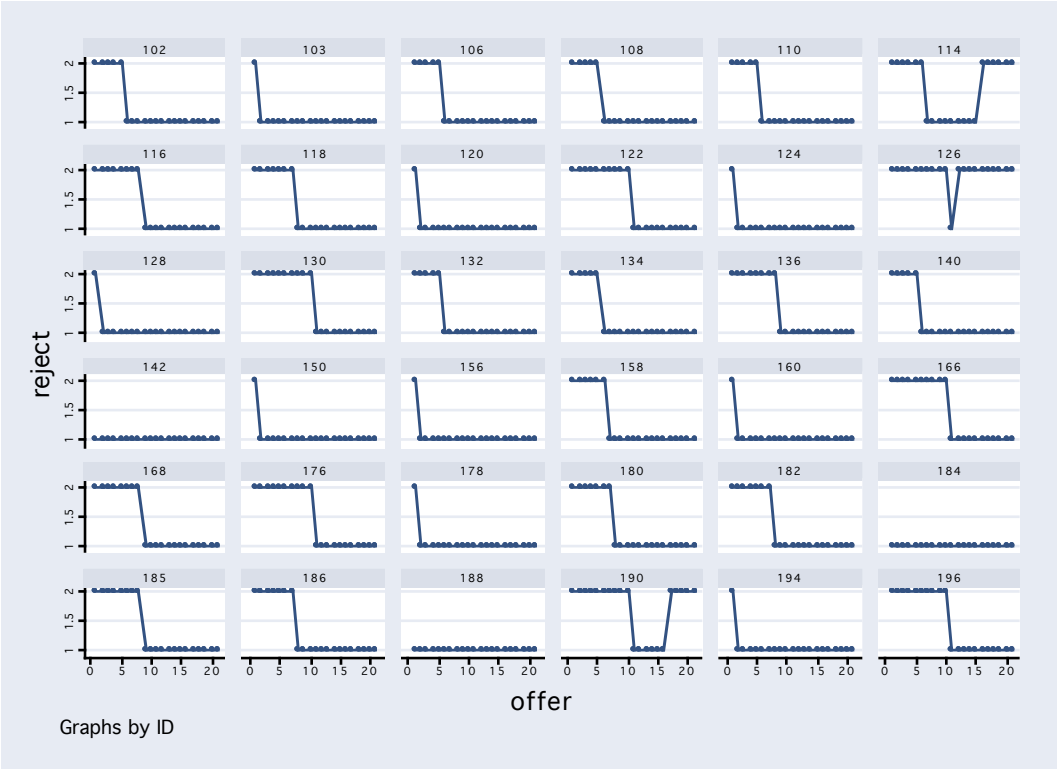

Figure 3b. Rejection profiles for the "neutral" manipulation. The vertical axis reflects whether the subject choose to reject or accept an allocation. The horizontal axis constitutes the offer to the responder, ranging from $0 to $20. Each subject's profile is plotted.

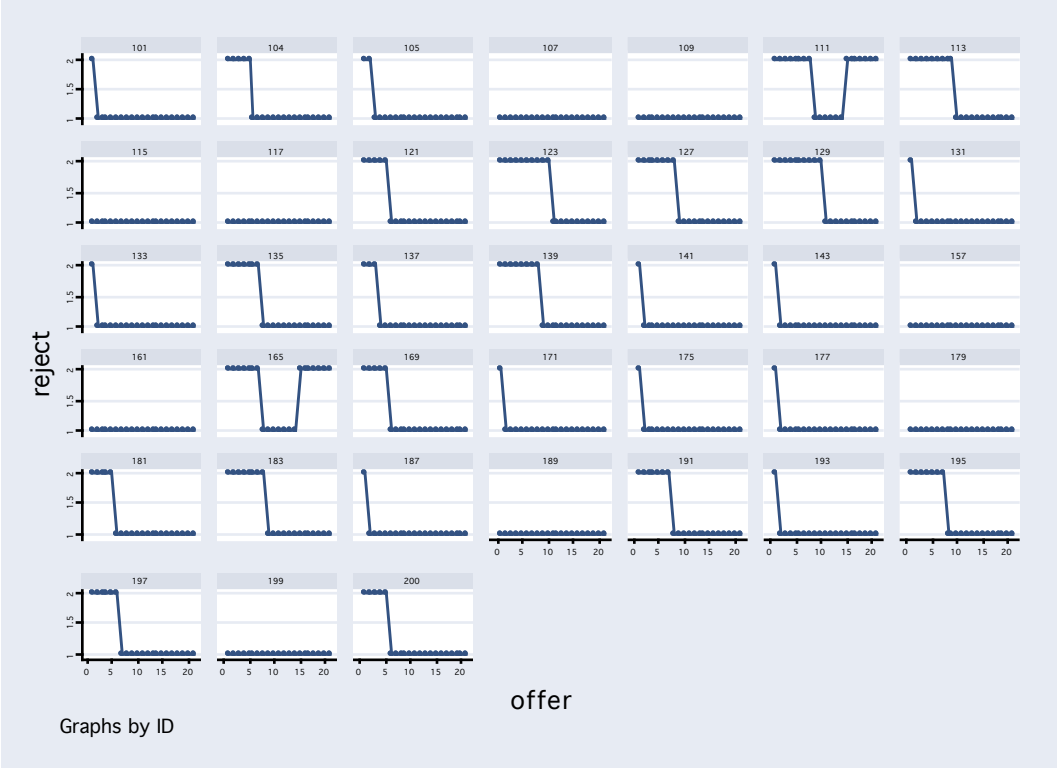

Figure 4. Percentage willing to accept an offer by experimental condition. The dark bars are percentage accepting a specific offer under the angry condition.