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# Neurophysiological Effects of Negotiation Framing

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## Abstract

In this study, we manipulated gain/loss framing context during a simulated negotiation between a human user and a virtual agent. Task instructions placed users either in a loss or gain framed context, such that those in the loss frame had to minimize expenses whereas those in the gain frame had to maximize profits. The virtual agent displayed facial emotions so that we could also test how interpersonal emotions interact with framing. Results suggest that individuals are more motivated to minimize their losses than maximizing their gains. The loss frame caused individuals to demand more during the negotiation, hence to minimize expenses. Neurophysiological results suggest that cardiovascular patterns of challenge (i.e., positive motivations) were present in the loss frame condition, most strongly when the virtual human smiled. We discuss these results in regards to Prospect Theory. This work also has implications for designing and rigorously evaluating human-like virtual agents.

**Keywords:** Prospect Theory; Negotiation; Context and Emotion; Gain/Loss Framing; Human-agent interaction

## Introduction

Facing a situation with almost certain loss looming, individuals are generally more likely to engage cognitive processes to take risks. Conversely, facing almost certain gain, individuals are more likely to be risk averse. A concrete example of this is to consider a situation in which two individuals are presented with \$100. One of them, Bob, is given the option of either (A) definitely keeping \$40 or (B) taking a gamble with a 75% probability of winning the entire \$100 (and 25% probability of losing everything). The other individual, John, is given the option of either (A) definitely losing \$60 or (B) taking a gamble with a 75% probability of winning the entire \$100. On average, research in experimental economics, game theory, and psychology has shown that individuals in Bob's decision frame would more likely be risk averse and choose (A), whereas individuals in John's situation would more likely be risk seeking and choose (B).

The goal of this work is to understand the behavioral and neurophysiological impacts of framing in an interpersonal decision making task, such as negotiation. Framing

phenomena have been well studied, and have led to Prospect Theory (Kahneman & Tversky, 1979), which suggests that that people are more motivated to take greater risks in order to avoid losses, because "*Losses loom larger than gains* (Kahneman & Tversky, 1979, p. 279)." Related research has focused on the effects of framing on negotiation behavior. For example, how a negotiation is framed can affect how an individual approaches, views and responds to the negotiation partner. For example, Bazerman, Magliozzi and Neale (1985) manipulated framing in a free-market negotiation context, where participants could engage in multiple negotiation transactions, by instructing half of the participants to maximize their profits (gain frame) and the other half to minimize expenses (loss frame). Their results indicated that individuals in the gain frame completed more negotiations compared to those in the loss frame, suggesting that the framing context affected negotiation outcomes.

Another relevant cue in negotiation is the emotional state of the negotiator. Carnevale (2008) investigated the relationship of both negotiation frame outcome and felt affect. He manipulated affect using a mood induction paradigm that involved giving participants a small, clear plastic bag full of chocolates. Results from Carnevale's (2008) study suggested that participants demanded more in the loss frame than in the gain frame when they were not given candy. Conversely, in the positive affect condition, the opposite occurred such that individuals in the gain frame demanded more in the negotiation.

Carnevale's work suggested that positive affect led to a reference point shift to the right of the origin in the classic Prospect Theory value function, and this induced a downsizing of loss differences and an upsizing of gain differences. This explains why individuals in a gain frame demanded more relative to those in the loss frame. Inducing positive affect caused individuals to behave in the opposite direction in the loss frame; they demanded less in the negotiation task than those in the control condition, who did not experience the mood induction paradigm.

In addition to felt affect playing a role in negotiation, emotional displays by a negotiation partner can conceivably affect the goals and related emotions of a negotiator. It is

expected that two parties will display emotions when negotiating over a set of issues, whether their goal is to obtain the best outcome for themselves or arrive at an integrative solution that maximizes the joint gain. Effective negotiation involves not only expressing appropriate emotional responses, but also understanding the effects of others' emotions on the self (de Melo, Carnevale, Read, & Gratch, 2014; Khooshabeh et al., 2013). Emotional appraisals can be inferred from behavior during a task or by asking participants using subjective questionnaire survey instruments. It is also plausible to index the effect of social cues, such as emotions, on negotiators at an implicit level by using advanced neurophysiological measures.

### **Inferring Psychological States from More than Just Behavioral Performance Measures**

Many researchers have demonstrated the role of emotions as social information in motivated performance tasks such as negotiations (Choi, de Melo, Khooshabeh, Woo, & Gratch, 2015; van Kleef, De Dreu, & Manstead, 2004). In addition to behavioral performance during a negotiation task, other measures can index the social effects of emotion, such as psychologically driven neurophysiological states. The biopsychosocial (BPS) model (Blascovich & Mendes, 2010) is a theoretical account of how a complex, multivariate pattern of cardiovascular responses indicates states of task engagement as well as motivational polarity; i.e., "challenge" and "threat." A challenge state indexes when an individual appraises her resources as exceeding demands in a situation, thereby having positive motivation and higher coping potential, whereas threat indicates when an individual appraises demands in a situation as exceeding resources.

Briefly, the BPS model is based on the neuroendocrine underpinnings (i.e., Dienstbier, 1989) of cardiovascular responses involving the sympathetic-adrenal-medullary (SAM) and hypothalamic pituitary-adrenal-cortical (HPA) axes. Both challenge and threat states involve the activation of the SAM axis, while only the threat state involves both axes. Accordingly, activation of common SAM axis neural and adrenal medullary endocrine processes affect cardiovascular responses underlying both challenge and threat, including increased heart rate (HR) and increased ventricular contractility (VC; i.e., decreased pre-ejection period or "PEP"), both of which index task engagement. Cardiac output (CO) and total peripheral resistance (TPR) patterns differ depending on motivational state. A challenge state results in decreased TPR and an increase in CO, whereas a threat state leads to little or no change or a decrease in CO and little or no change or an increase in TPR (Blascovich & Mendes, 2010).

Psychologically, challenge motivation occurs when an individual's consciously and/or unconsciously evaluated resources outweigh consciously and/or unconsciously evaluated task demands. Threat occurs when resources are evaluated as not meeting task demands. For example,

situations that involve uncertainty, which can result from unexpected social cues, have been found to implicitly increase demand evaluations relative to resources (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). The BPS model of challenge and threat gives insights into appraisals of resource and demand ratios through the lens of a complex set of cardiovascular responses.

The BPS model also gauges the effect of outcome framing when there is no other social counterpart in a decision making context. In a study by Seery, Weisbuch and Blascovich (2009), participants were given a cognitive test. Half the participants were told that they could make as much as five dollars and would receive a monetary reward of \$0.50 for each item they answered correctly. The other half of the participants was told that they would begin the task with five dollars and would incur a penalty of \$0.50 for each item they did not answer correctly. Expected values in both conditions were the same; however one outcome was framed as a gain and the other as a loss. Their results indicated that participants in the gain frame experienced challenge (decreased TPR), while those in the loss frame experienced threat (increased TPR). This suggests that the BPS model has been validated to detect psychological states that correspond to decision frames. However, it remains to be seen whether psychophysiological states in this unitary cognitive task generalize to dyadic decision making tasks such as negotiation.

### **Hypotheses**

**Loss framing will lead to greater demand** Based on Prospect Theory, we predicted that individuals in the loss frame condition would be motivated to minimize their expenses compared to those in the gain frame because losses loom larger. Accordingly, those in the loss frame are predicted to make fewer concessions (i.e., greater demands).

**Affective Facial Expressions** If positive facial expressions from a negotiation opponent have the same effect on observers as a positive mood-induction, then individuals in the happy/gain condition should make more demands in the negotiation based on Carnevale (2008). As Carnevale (2008) noted, "An interesting follow-up experiment may be to examine reference dependence in expected negotiation outcomes driven by perceived negative and positive affect of the adversary. (p. 60)". The connection between mood-induction using chocolate versus a positive facial expression is potentially tenuous, but this warrants an empirical study of whether positive facial expressions simply induce positive moods. For this study, affect was manipulated via the virtual agent who displayed either angry, happy, or neutral facial expressions (control), which were previously validated (Khooshabeh et al., 2013). We included an angry expressive

virtual agent as an exploratory investigation on the effects of negatively valenced interpersonal affect.

**Framing and Motivational State** According to Seery et al. (2009), framing outcomes in terms of a potential for loss led to lower CO and greater TPR (consistent with relative threat, which is more negatively valenced than challenge). But it is possible that the mechanism by which gain/loss framing worked in the context of their singular, cognitive motivated performance task would be different in situations that involve dyadic negotiation as a function of affect information transmitted by one partner or the other. In particular, given that losses loom larger, individuals should be more positively motivated (i.e., challenged) to overcome expenses (as in the loss frame) than maximize profits (as in the gain frame). Moreover, the frame effect can be interpreted in terms of risk in the negotiation. Negotiators are generally risk tolerant in a loss frame (Carnevale, 2008), thereby making greater demands (i.e., fewer concessions) and risking non-agreement; the opposite takes place in a gain frame, such that negotiators are risk averse, hence making more concessions to reach agreement. Based on this *risk framing hypothesis*, we predict that loss framing should cause relative challenge compared to gain framing. Similarly, gain framing should cause greater relative threat compared to loss framing.

## Methods

### Participants

Participants were 162 undergraduate students (90 males, 72 females) at the local university, ranging in age from 18 to 24 ( $M = 19.2$ ,  $SD = 1.22$ ) and were granted course credit for their participation.

### Design

Participants were instructed to maximize points or minimize loss. Specifically, their role was to sell home appliances by negotiating multiple issues, which included delivery time, discount terms, and financing terms. The participants used the mouse to make offers to the interactive virtual agent (buyer) which displayed either an angry, neutral or happy facial expression after participants made an offer on rounds 1, 3 and 5. The virtual buyer conceded two levels on one of the issues per round, which is deemed to be moderate in prior research (van Kleef et al., 2004); the task lasted six rounds where the participants would make counter-offers to the virtual agent's initial and ensuing offer. Participants could reach an agreement with the virtual agent by either accepting the virtual agent's offer or lowering their offer to match a previous offer from the virtual agent.

In order to analyze the full effect of the virtual human's facial expressions across the whole task, an exclusion criterion was applied to remove participants who agreed to the virtual agent's offer before the sixth round. The reason for doing that was because those participants would not have

experienced the entirety of the virtual agent's emotional facial displays. The study used a 2 (gain frame/loss frame) x 3 (angry/happy/neutral) factorial between-subjects design. Participants were randomly assigned to conditions via computer program based on the "round robin" technique.

**Frame** Participants were randomly assigned to complete the task with instructions that effectively put them in a loss or gain frame context. They were informed that 8000 points represented the highest profit they could obtain. In the gain frame, they were informed that the worst negotiation outcome was zero points on each of three issues and the best outcome was the maximum 8000 points. They were instructed to maximize profits. In contrast, loss frame participants were told to minimize their expenses. They were told that -8000 represented the highest expenses, and hence, the worst negotiation outcome. An expense of zero points on each issue represented the best negotiation outcome in the loss frame condition (see Table 1).

An example will help illustrate how the same negotiation outcomes would result in a mathematically equivalent number of points in each frame. For example, a participant might arrive at a negotiation outcome of level 3 for the issue of delivery time, 5 for discount terms, and 4 for finance terms. In the loss frame, this corresponds to expenses of -4900 ( $-1200 - 1200 - 2500 = -4900$ ). The -4900 expense would cut into a total possible profit of 8000, so the resulting profit would be 3100 points ( $8000 - 4900 = 3100$ ). The same level 3-5-4 for the three issues would result in 3100 points in the gain frame ( $400 + 1200 + 1500 = 3100$ ).

Participants and the virtual agent could vary each of their offers on each of the three issues from levels of 1 to 9, with 9-9-9 representing the optimal profit (see Table 1); the negotiation behavior of the virtual agent was fixed such that the initial offer was 1-2-1 and he conceded two levels for one of the issues on each round (see Khooshabeh et al, 2013). The negotiation task interface reflected in real time the number of points the participant earned or lost after each offer that the virtual agent made and with each counter-offer the participant provided.

Table 1. Expenses incurred at each level in the loss frame; (Parentheses: Profit at each level in the gain frame).

Level	Delivery Time	Discount Terms	Financing Terms
1	-1600 (0)	-2400 (0)	-4000 (0)
2	-1400 (200)	-2100 (300)	-3500 (500)
3	-1200 (400)	-1800 (600)	-3000 (1000)
4	-1000 (600)	-1500 (900)	-2500 (1500)
5	-800 (800)	-1200 (1200)	-2000 (2000)
6	-600 (1000)	-900 (1500)	-1500 (2500)
7	-400 (1200)	-600 (1800)	-1000 (3000)
8	-200 (1400)	-300 (2100)	-500 (3500)
9	0 (1600)	0 (2400)	0 (4000)

**Physiological responses** Participants' cardiovascular responses were measured during the task using a BIOPAC MP150 system and related amplifiers (Goleta, CA). Electrocardiographic (ECG) signals were recorded using an electrocardiograph amplifier (Model ECG100C). Blood pressure was recorded via the continuous non-invasive arterial pressure (CNAP) monitor (Model NIPB100F). Impedance cardiography was collected using a tetra-polar aluminum/mylar tape electrode system (Model NICO100C) secured around the participant's neck and torso and an impedance cardiograph.

## Procedure

Participants were brought to the lab. Prior to beginning the experiment they completed an informed consent form. A female research assistant then placed impedance tape and the other electrodes on the participant's neck and torso followed by a blood pressure cuff on the brachial artery of the participant's upper arm (for calibration purposes only) and an additional cuff on the radial artery of the participant's index finger. After recording a five-minute resting baseline of physiological data, the participant was instructed to begin the negotiation task on a computer provided by the lab.

The participants first read instructions that described the scenario and task at hand and then were asked four follow-up questions to ascertain that they understood the instructions. As an added incentive to motivate successful performance during the task, participants were told that they had a chance of winning the distinction of "top negotiator" by both (1) reaching an agreement with the virtual agent negotiation partner and (2) earning the highest profit. They first engaged in a practice round to familiarize themselves with the negotiation task interface before beginning the negotiation task. Unbeknownst to participants beforehand, the task ran for 6 rounds and the virtual agent's offers were preset. Upon completion of the negotiation task, participants were asked to complete survey questionnaires and then were debriefed and thanked for their participation.

## Results

### Negotiation Performance

First, all the demand scores were normalized so that they were on the same scale ranging from 0-8000 possible points available in the negotiation task. The scores in the gain frame were already in this format; we normalized the scores of participants in the loss frame by adding a value of 8000 to them so that they would be in the same range as those in the gain frame. A 3 (Emotion: Angry, Happy, Neutral) x 2 (Frame: Gain vs. Loss) ANOVA was conducted on the demand scores.

We computed average demand over the six rounds of the negotiation. There was no effect of emotion,  $F(2, 156) = 1.48, p = .23, \eta_p^2 = .019$ . There was a significant effect of

frame,  $F(1, 156) = 10.9, p = .001, \eta_p^2 = .07$ . Participants in the loss condition demanded more on average ( $M = 5872, SE = 249$ ) compared to those in the gain condition ( $M = 4695, SE = 256$ ). This supports the *risk framing hypothesis* that predicted loss framing would motivate participants to demand more in the negotiation. There was no significant interaction of the emotion and frame variables,  $F(2, 156) = 1.52, p = .22, \eta_p^2 = .019$ .

Another measure of negotiation performance was the amount by which the initial offer differed from the final offer in the negotiation. This demand difference (concession) score was computed by subtracting the number of points demanded in the last round from those demanded in the first round. The ANOVA on the demand difference score indicated that there was no significant effect of emotion ( $F < 1$ ) and no effect of framing ( $F < 1$ ), but there was a marginally significant interaction of emotion and framing,  $F(2, 156) = 2.85, p = .061$ . An exclusion criterion was applied to remove participants who agreed to the virtual agent's offer before the sixth round. The reason for doing that was because those participants would not have experienced the entirety of the virtual agent's emotional facial displays. The interaction emotion and framing was significant based on this exclusion criteria,  $F(2, 147) = 3.35, p = .038, \eta_p^2 = .044$ . Demand difference in the gain frame, anger emotion condition ( $M = 1300, SE = 290$ ) was greater than the demand difference in the gain frame, neutral emotion condition ( $M = 245, SE = 309$ ),  $F(2, 147) = 3.16, p = .045, \eta_p^2 = .041$  (Figure 1). This suggests that participants conceded more to the angry virtual agent in the gain condition, which replicates previous results (van Kleef et al., 2004). However, in the loss condition, the virtual agent's emotional facial display did not affect the demand difference (Figure 1). Therefore, the gain/loss context mediates the effect of anger emotional facial expressions.

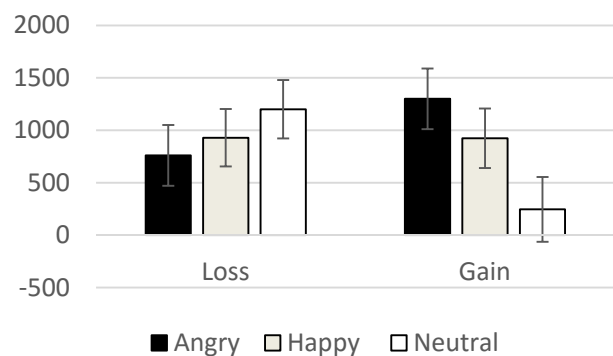


Figure 1. Concession computed by demand difference (Round 1 offer - Round 6 offer). Greater values indicate greater concession. Standard error bars.

### Psychophysiological States

The behavioral results from the negotiation task replicated previous work by Carnevale (2008). He found that average

demand over the repeated rounds of the negotiation was greater in the loss frame condition than in the gain frame condition. This suggests that participants were more motivated to minimize their expenses in the loss condition compared to maximizing their profits in the gain condition. Based on these results and the *risk framing hypothesis*, we predicted that the negotiators' neurophysiological state would indicate challenge motivation in the loss frame.

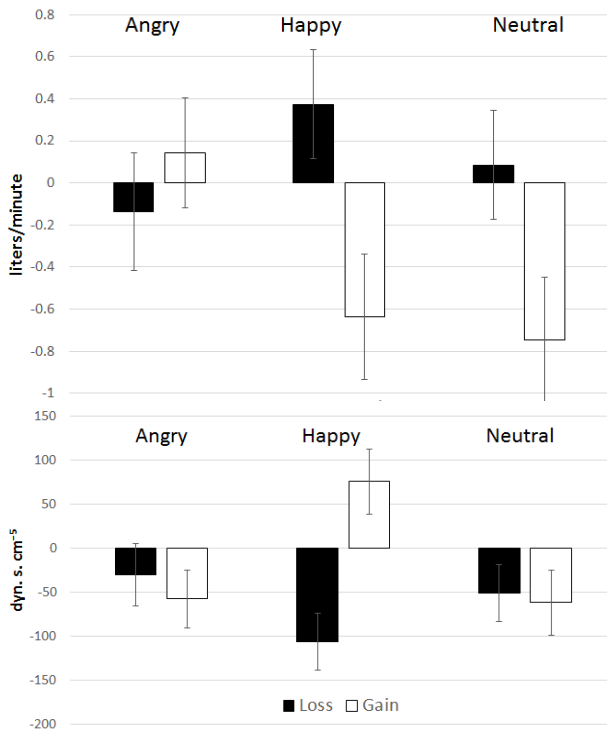


Figure 2. Cardiovascular responses. Top: Cardiac Output (CO); Bottom: Total Peripheral Resistance (TPR)

Physiological reactivity scores were calculated by subtracting the CO and TPR measures of last minute of baseline from those in the first minute of the task.<sup>1</sup> A multivariate ANOVA was conducted on these measures with the independent variables of Frame (gain vs. loss) and Emotion (angry, happy, and neutral). The multivariate tests indicated a significant effect of Frame,  $F(2, 106) = 3.6, p = .03, \eta_p^2 = .063$ , and a significant Frame by Emotion interaction,  $F(4, 214) = 4.0, p = .004, \eta_p^2 = .07$ . The effect of Emotion was not significant,  $F < 1$ .

Univariate tests indicated that the effect of Frame was significant for the CO reactivity measure,  $F(1, 107) = 5.32, p = .023, \eta_p^2 = .047$ . In the loss condition, CO reactivity was positive ( $M = .12, SD = .88$ ), which indicated that individuals in the loss frame were challenged. In the gain condition, CO

reactivity was negative ( $M = -.36, SD = 1.5$ ), which indicated that individuals in the gain frame were threatened.

Univariate tests of the Frame by Emotion interaction indicated that the effect was significant for the CO reactivity measure,  $F(2, 107) = 4.64, p = .042, \eta_p^2 = .06$ , and the TPR reactivity measure,  $F(2, 107) = 5.6, p = .005, \eta_p^2 = .095$ . Bonferroni corrected simple-effects analyses were conducted for each measure. The results suggested that neurophysiological reactivity to gain and loss frames differed only in the happy emotion condition,  $F(2, 106) = 8.75, p < .001, \eta_p^2 = .142$ . Increased CO reactivity ( $M = .374, SD = .996$ ) and decreased TPR ( $M = -106, SD = 83.4$ ) in the loss/happy condition indicated a challenge motivational state. In contrast, CO reactivity decreased ( $M = -.634, SD = .889$ ) and TPR increased ( $M = 75.4, SD = 205$ ) in the gain/happy condition, which indicated a threat motivational state (Figure 2).

## Discussion

In summary, the results here indicate both conscious and non-conscious reactions to contextual cues such as framing. The behavioral performance during the negotiation task suggests that participants in the loss frame were more demanding relative to those in the gain frame. Analysis of neurophysiological states also supports this behavioral finding that those in the loss frame were more motivated to profit from the negotiation. Cardiovascular measures indicate that individuals in the loss frame exhibited a pattern of physiological responses indicative of a challenge motivational state.

Seery et al. (2009) did not report whether framing affected task performance on the cognitive test whereas our study showed a similar pattern across both the cardiovascular responses and the behavioral performance in the negotiation task. In particular, the results in this study suggest that individuals in a loss frame are not only in a challenge motivational state, but also demand more in the negotiation. These results provide a novel contribution to Prospect Theory, namely that peripheral neurophysiological measures can index when individuals are more motivated to take greater risks in order to avoid losses, because "*Losses loom larger than gains* (Kahneman & Tversky, 1979, p. 279)." Cardiovascular physiology is a nonconscious autonomic process, but negotiation behavior is under conscious control. The fact that two drastically different types of data produced congruent findings serves to strengthen our results.

A positive emotional facial expression displayed by the embodied virtual agent did not seem to have the same effect as a positive mood induction (Carnevale, 2008). There are at least two possible factors that could account for this. First, interpersonal emotional expressions can have complex effects on observers beyond mere emotional contagion as

<sup>1</sup> Due to equipment failure, physiological data for 47 participants was lost.

identical facial expressions can lead to different interpretations based on context (Barrett, Mesquita, & Gendron, 2011; Choi et al., 2015; Khooshabeh et al., 2013; Szczurek, Monin, & Gross, 2012). Therefore, it is possible that the appraisal of the embodied agent's smile in the loss frame condition could be different from the appraisal in the gain frame condition due to changes in context. The second factor that might account for why a positive facial expression did not have the same effect as Carnevale's mood induction paradigm could be due to slight differences in the experimental protocol. Embodied virtual agents in this study displayed emotional facial expressions at a few distinct times throughout the negotiation. Conversely, the positive mood induction in Carnevale's study was only done before and after the instructions, but not during the actual negotiation. This difference in the timing of the affect might account for the different outcomes in framing compared to Carnevale (2008).

Results can help generate design guidelines for virtual agent developers to create negotiation scenarios that convey a gain frame if the goal is to make negotiators demand less from a negotiation agent. For the design of training systems, the goal might be to motivate negotiators more positively when they are learning effective negotiation. To accomplish that, negotiation tutors could engender a neurophysiological state of positive motivation (i.e., challenge).

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