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## Subjective Effectiveness in Agent-to-Human Negotiation: A Frame x Personality Account

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**Abstract.** This paper presents an empirical examination on the role of framing as a persuasion technique in agent-to-human negotiations. The primary hypothesis was that when a software agent frames the same offer in different ways it will have different consequences for a human counterpart's perceptions of the negotiation process and outcomes. A secondary hypothesis was that the subjective effectiveness of different frames will be influenced by the personality of the human counterpart. An experiment to test these hypotheses was conducted using a simulated software seller agent and a human buyer counterpart in a 4-issue negotiation task. The results demonstrated the influence of framing on human counterparts' judgments of subjective effectiveness—an influence that was moderated by the personality variable Need for Cognition. The findings illustrate the strategic impact of framing and personality on satisfaction in negotiation, suggesting that these variables should be taken into account in designing negotiating agents.

**Keywords:** frame, negotiation, satisfaction, personality, Need for Cognition, persuasion, agent-to-human negotiation, automated negotiation, experiment

### 1 Introduction

Recently, spurred no doubt by the rapid growth of the electronic marketplace, there has been increasing interest in applying AI techniques to the design of autonomous agents that serve as surrogates for human decision-makers. Previous research in the agent-based negotiation community has explored persuasion techniques for argumentation-based protocols in which agents accompanied their offers with their underlying reasons in agent-to-agent negotiation settings [1, 2]. However, relatively little is known about the dynamics of argumentation and persuasion in agent-to-human negotiation contexts [3].

In an open, e-market environment, a software agent acting on behalf of its principal might have to negotiate with another software agent, or with a human agent. In the latter case, wherein a software agent negotiates with a human agent, it might be helpful for the software agent to be equipped not only with sophisticated intelligence,

but also with the kind of artful skills that enable strategically advantageous interactions [3, 4]. Thus *agent-to-human negotiation* creates a new and interesting area for research—one which bridges the gap between how negotiation is performed in human and in artificial worlds.

An important aspect of negotiation dynamics that social scientists who study cognitive processes, decision making, persuasion, and communication have studied is *framing*—a persuasion technique widely used in human-to-human communication. In decision theory terms, a *frame* refers to a “decision-maker’s conception of the acts, outcomes, and contingencies associated with a particular choice” [5] (p. 453). The (software) agent-to-human negotiation context allows the examination of framing not only in terms of its economic, utility-based, effects but also in terms of its subjective consequences for human negotiation counterparts, and it is this aspect of framing that is the primary focus of this paper. Simply put, we explore the impact of different message frames on *subjective effectiveness*, defined as the extent to which an individual perceives positive psychological experiences in a negotiation situation [6].

Recent social psychological research suggests that there are four underlying dimensions in terms of which the subjective outcomes of a negotiation can be characterized: Feelings about the self, Feelings about the instrumental outcome, Feelings about the process, and Feelings about the relationship [7]. Such psychological perceptions are associated with long-term consequences such as willingness to interact with the same counterpart in future [6, 7]. Prior research has established that when the same information (logically speaking) is presented using different frames, the emotions people experience depend on whether they tend to focus on their aspirations or their obligations (i.e., on their regulatory focus) as they pursue their goals [8]. This raises the possibility that the differential impact of gain and loss frames might extend to different people’s psychological perceptions in different ways. Another respect in which individuals might differ in how they respond to different message frames relates to their *motivation to process the information*. In the present study, when manipulating message frames, the economic utility of the offer is kept constant, so the messages do not differ in their substantive content. Differences in people’s motivation to process information is captured by the Need for Cognition personality variable, the measurement scale for which assesses the tendency to engage in and enjoy effortful cognitive activity, or thinking [9]. In summary, we address the following two questions:

1. When a negotiating agent presents an offer to its human counterpart, how do different message frames (of the same offer) affect the counterpart’s subjective evaluations of the negotiation process and outcome?
2. Do aspects of the human counterpart’s personality moderate any such effects?

## 2 Message Frames

Among various types of message frames examined in the persuasion literature (e.g., image-focused versus quality-focused frames [10], affective versus cognitive frames [11]), one of the most extensively studied framing strategies are gain and loss frames [12]. Gain frames focus on the benefits of taking action whereas loss frames focus on

the costs of failing to take action, both relative to the same desired state of affairs (e.g., [13]). For example, relative to the desired state of good cardiac health, a typical gain frame focuses on the potential beneficial outcome of having a healthy heart resulting from action: “If you follow this diet, you will have a healthy heart”. In contrast, a typical loss frame focuses on the potential costly outcome of getting heart disease resulting from inaction: “If you don’t follow this diet, you will get heart disease”. Note that in these examples, the gain and loss frames are isomorphic with engaging and not engaging in action. The frames focus only on the presence of a gain or a loss–action for the gain, inaction for the loss.

However, it is also possible to consider frames that focus on the *absence of gains* (i.e., non-gains) and the *absence of losses* (i.e., non-losses). Continuing with the example of good cardiac health, a non-gain frame would be “If you don’t follow this diet, you will not have a healthy heart,” while the corresponding non-loss frame would be “If you follow this diet, you will not get heart disease.” Table 1 illustrates the possible frames that can occur when the absence/presence dimension is crossed with the gain/loss dimension.

**Table 1.** Example of gain/loss frames crossed with presence/absence

	Presence	Absence
Gain	<b>Gain</b> If you follow this diet, you will have a healthy heart.	<b>Non-gain</b> If you don’t follow this diet, you will not have a healthy heart.
Loss	<b>Loss</b> If you don’t follow this diet, you will get heart disease.	<b>Non-Loss</b> If you follow this diet, you will not get heart disease.

Framing has been studied extensively with respect to how it affects people’s behavior and their perceptions, especially their perceptions of risk. For example, an important finding resulting from Prospect Theory [14] indicates that people are more risk-averse when a decision problem is framed as a possible gain, and more risk-tolerant when it is framed as a possible loss. In general, many studies suggest that people tend to respond differently when presented with the possibility of gaining something as opposed to not losing something, or losing as opposed to not gaining something (e.g., [15]). Compared to conditions when outcomes are framed as losses or non-gains, negotiators tend to make fewer concessions and reach fewer agreements when outcomes are framed as gains or non-losses [16]. However, a recent meta-analysis [12] of 165 cases involving a total of more than 50,000 participants revealed that overall, loss frames were no more persuasive than gain frames.

Our work differs from existing research in two important respects. First, in the meta-analysis [12], gain frames and non-loss frames were classified together as gain frames, and loss and non-gain frames were classified together as loss frames. It is possible that these connotations (necessitated by the studies included in the analysis) mask differences that might have been found had gain and non-loss frames, and loss and non-gain frames been separated. In the present work, we considered both the *absence-presence* distinction and the *gain-loss* distinction. Second, disagreements about the effectiveness of frames basically revolve around the question of whether frames affect behavioral compliance or attitudes toward the recommended behavior.

However, our interest is in the *subjective effectiveness* of framing in negotiation, so our focus is on participants' perceptions toward the negotiation settlement, the counterpart, and the self.

An important subjective outcome of a negotiation is the negotiator's judgment about the faithfulness, friendliness, and flexibility of the other [6, 7]. When we apply the four distinctive frames in negotiation context, the gain and non-loss frames can be thought of as corresponding to a "promise" message whereas the loss and non-gain frames communicate a kind of "threat". Threats and promises are conditional commitments by the sender to do desirable or undesirable things for the message recipient as a function of the recipient's response [17-19]. In our context, when the final offer is presented as "if you don't accept my offer, I won't give you the free service-upgrade" (non-gain) or "if you don't accept my offer, I'll charge you for the service-upgrade" (loss), the offer has the form of a threat. This contrasts with offers in the form of promises, as in "if you accept my offer, I will give you a free service-upgrade" (gain) and "if you accept my offer, I won't charge you a free service-upgrade" (non-loss). It is easy to imagine that threats would elicit in the message receiver negative perceptions (e.g., of aggressiveness) of the message sender [20]. Research has suggested that threats that are more compelling [21], or that are associated with greater clarity [22, 23], or that can be presented in early-explicit or late-implicit manners [24] tend to be perceived more aggressive than otherwise. Therefore, when negotiators feel threatened, they are more likely to develop an aggressive/negative impression of the message sender, whereas they are more likely to experience more positive feelings towards the counterpart when the message is framed as a promise.

The various considerations discussed above, lead to the following two hypotheses:

*Hypothesis 1.* Negotiators are more likely to feel *satisfied with respect to their counterparts* when they accept offers with "promise" frames (gain/non-loss frames), than when they accept offers with "threat" frames (loss/non-gain frames).

In addition to considering how a negotiator feels about the other party, he or she is also likely to have feelings about the settlement per se. In fact, *satisfaction with the settlement* is the subjective outcome most usually evaluated in computer-supported negotiation experiments (e.g., [25-29]). *Satisfaction with the settlement* relates primarily to the subjective belief that a negotiator has achieved a fair, desirable, and/or efficient solution. We know from previous studies [e.g., 30, 31] that negotiators are more willing to make concessions when presented with a gain frame than with a loss frame. It is reasonable to suppose that the way in which a concession is made will influence other subjective perceptions such as feelings about the settlement and about oneself. That is, the subjective sense that one conceded voluntarily as opposed to having been pressured to concede might lead to a greater sense of satisfaction with the settlement, even though the objective outcomes don't differ—hence, the second hypothesis.

*Hypothesis 2.* Negotiators are more likely to feel *satisfied with respect to their settlements* when they accept offers with "promise" frames (gain/non-loss frames), than when they accept offers with "threat" frames (loss/non-gain frames).

### 3 The Moderating Role of Personality

The subjective effectiveness of a negotiation framed with gain, non-loss, non-gain, and loss frames is likely to be complicated by aspects of the recipient's cognitive-processing patterns. One interesting example of such processing patterns or styles is illustrated by recent research suggesting that processing *negation*, which involves higher order rule-based processes, is more cognitively demanding than processing material that does not involve negation [32]. Since offers presented with non-gain or non-loss frames involve negation, they require more cognitive effort to process than offers presented with gain or loss frames. This gives rise to (at least) two interesting possibilities. First, people might be insensitive to non-gain and non-loss frames. Therefore, the subjective effectiveness of a non-gain frame would be lower than that of a gain frame (but still higher than that of a loss frame), whereas the subjective effectiveness of a non-loss frame would actually be higher than that of a loss frame (but still lower than that of a gain frame). Another possibility is that people might be put off by the cognitive demands of non-gain or non-loss frames such that the subjective effectiveness of a non-gain frame would not only be lower than a gain frame but also a loss frame, with the same pattern observed for a non-loss frame. Therefore, the effect of framing on the subjective evaluations of a negotiation might well be moderated by the personality of the offer recipient, a possibility that we explore in terms of *Need for Cognition*.

The *Need for Cognition* (NC) personality variable characterizes an individual's chronic tendency to take on and enjoy effortful cognitive activities. People who are high in NC typically show an orientation toward mental challenges [33]. For instance, a high NC individual is more likely to have a positive attitude toward tasks that involve reasoning or problem solving, and which require considerable use of cognitive resources. Conversely, individuals who are low in NC are more dependent on heuristics (i.e., cognitive "short cuts"), external source (e.g., experts), or other processes which serve to simplify or reduce information processing. Such individuals prefer tasks that are relatively simple and which take less toll on their cognitive resources [14]. The role of NC in social psychological processes has been examined extensively in the psychology literature, with studies typically assessing NC using Cacioppo and Petty's *Need for Cognition Scale* [9]. This measure has demonstrated good reliability and the ability to predict a variety of outcomes in combination with other factors, and has revealed reliable differences not only in self-reported motivation but also in actual processing behavior [34].

In persuasion research, NC has been found to interact with the argument quality of persuasive messages to predict attitude change. In general, individuals high in NC distinguish strong and weak arguments to a greater extent than do those low in NC (e.g., [35-37]). On the other hand, individuals with low NC have also been found to differentiate source factors such as source attractiveness and perceived honesty more than those with high NC [36, 38]. Persistence of attitudes over time has also been found for those high but not low in NC [36, 39]. In the negotiation context, where information takes the form of negotiators' offers, we expect differences in negotiators' NC to result in different perceptions of the bargaining situation, and consequently, their attitude towards the process and outcome of the negotiation.

Individuals high in NC have a natural inclination to process information to a greater extent, therefore they are likely to experience more positivity when accepting an offer presented with a relatively complex frame compared to individuals low in NC. As mentioned above, processing negation, as is required for non-gain or non-loss frames requires more cognitive resources [32], so it might be that individuals high in NC are more satisfied (or less dissatisfied) with the negotiation process and outcome when presented with non-loss/non-gain offers because such offers appear more mentally challenging to process. More importantly, high NC individuals would have a more positive experience when processing the seemingly complex offer, and consequently, attribute the positive experience to perceptions of how well they carried themselves during the negotiation. Conversely, gain/loss frames appear simple since they take the affirmed form, which does not require additional cognitive effort to process. As such, those low in NC might have a more pleasant (or less unpleasant) experience processing the simple-to-digest gain/loss frames, and consequently develop more positive self-perceptions.

*Hypothesis 3.* High-NC negotiators are more likely to feel *satisfied with themselves* when they accept an offer with absence frames (non-gain/non-loss frames) as compared to presence frames (gain/loss frames), whereas low-NC negotiators are more like to feel *satisfied with themselves* when they accept an offer with presence frames (gain/loss frames) as opposed to absence frames (non-gain/non-loss frames).

## 4 Experiment

### 4.1 The Design

A 2x2 between-subject factorial experiment was designed to test our hypotheses. The negotiation context was created through an experimental procedure in which participants were assigned the role of a buyer who had to undertake an on-line four-issue negotiation to purchase laptop computers. The four issues were unit price, quantity, service level, and delivery terms. Although participants were not explicitly told, in fact that the seller was represented by a software agent<sup>1</sup> embedded in the website. Participants were randomly assigned to different treatment conditions. Figure 1 presents the experimental design.

In order to fill all the cells in the design (as shown in Figure 1), ninety-six undergraduate students were recruited from a large university. The data of participants who did not accept the seller's final offer (see Table 2) were discarded. As a means of encouraging participants to negotiate realistically for a "good deal," participants were told that not only would they receive \$10 cash after the experiment, but that they would get an additional \$10 if they were to achieve a utility score in the top 30%. In fact, all participants ended up with the same offer from the seller agent, and all were given an additional \$10 after all of the experimental sessions were concluded.

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<sup>1</sup> The software agent system was designed and developed for a research program that explores the influence of factors that play an important role in agent-to-human negotiations [1, 40].

		Presence-Absence Frame	
		Presence	Absence
Gain-Loss Frame	Gain	<b>gain</b> 13 participants	<b>non-gain</b> 13 participants
	Loss	<b>loss</b> 13 participants	<b>non-loss</b> 13 participants

**Fig. 1.** The Experimental Design. Each treatment cell included data from 13 participants who accepted the seller agents' final offer in one of the four framing conditions (gain, non-gain, loss, and non-loss).

## 4.2 Negotiation Task

The task was adapted from a validated negotiation scenario based on real-world manufacturing contract negotiations originally developed by Jones [41] and used in various computer-based negotiation experiments (e.g., [25, 27, 28, 40]). Participants (buyers) were provided with a private utility table from which they could compute the utility of an offer by summing the utilities of each of the four issues in the offer. The structure of the task created 728 discrete alternatives to the negotiation agreement with utilities ranging from 0 to 100. In order to create a realistic "bottom line" condition, both buyers and the seller were given the same bargaining power, namely, BATNA (Best Alternative to a Negotiated Agreement) [42, 43] values that represented 44 utility points. Participants were told that they should obtain an agreement with as high a utility as possible, but because a reserve agreement already existed, there was no point in reaching an agreement with a utility below 45.

## 4.3 Independent Variable and Controlled Variables

There were two levels each of the two independent variables, corresponding to the four frames used by the selling agent to present the final offer—an offer which participants could either accept or reject. The objective effectiveness (utility) of the final offer was the same in all conditions and was designed to be sufficiently appealing that most participants could be expected to accept it.

Table 2 below illustrates how the four frames were presented in the final round of agent offers as they correspond to the gain/loss x absence/presence manipulation.

The negotiation rules were controlled by using the same one-way protocol for all conditions. The rule simply stated that the negotiation proceeds in rounds, at each round the seller will send an offer for the buyer to either accept or reject. The negotiation is completed when the buyer accepts one offer (agreement is achieved) or the buyer rejects the seller's final offer. The same negotiation task was used in all conditions. The negotiation website interface was the same for all participants across all conditions, and the experiment was administered to all participants by the same experimenter using the same standardized instruction script for all sessions.



**Table 2.** Negotiation rounds. Frame manipulation only for final offer (Round 4)

	Seller's offer and accompanying message	Utility (from utility table)
Round 1	<p>Chris says: Hello! My name is Chris. I am a sales manager at LaptopOnDemand. Thank you for your interest in our products. For laptop sales, we typically require a minimum purchase of 100 units and we can only ship in units of 20, with an average of 2 weeks for delivery. Sometimes, we are able to give a discounted price and a service upgrade.</p> <p>The following offer package comes with "Silver" service level. I can give you \$2250/unit and deliver in 3 weeks, provided that you will take 160 units</p>	<p>Unit Price: \$2250/unit (13) Quantity: 160 units (8) Service Level: Silver (15) Delivery: 3 weeks (5)</p> <p>Total utility: (41)</p>
Round 2	<p>Chris says: Okay. I can give you a discount if you order more units. If you can take 200 units, I can give you them for \$2150/unit and delivery in 3 weeks. That would be with the "Silver" service level. What do you say?</p>	<p>Unit Price: \$2150/unit (27) Quantity: 200 units (3) Service Level: Silver (15) Delivery: 3 weeks (5)</p> <p>Total utility: (50)</p>
Round 3	<p>Chris says: Hmmm. Well if you take 200 units and are OK with having them shipped a week later, i.e., 4 weeks delivery, I can give you an even better discount: \$2050/unit. The service level is the "Silver" one. How does that sound?</p>	<p>Unit Price: \$2050/unit (39) Quantity: 200 units (3) Service Level: Silver (15) Delivery: 4 weeks (0)</p> <p>Total utility: (57)</p>
Round 4	<p>Chris says: Okay. How about this? 200 units at \$2050/unit, and 4 weeks delivery.</p> <p>This is the best I can do. However, since it's a large order, I might be able to manage a service upgrade. That's a \$2000 per annum value.</p> <p>&lt;frames inserted here&gt; What do you say?</p> <p>&lt;frame a – <b>gain</b>&gt; OK, so if you accept my offer this time, I'll give you the free service-upgrade to "Gold".</p> <p>&lt;frame b – <b>non-loss</b>&gt; OK, so if you accept my offer this time, I won't charge you for the service-upgrade to "Gold".</p> <p>&lt;frame c – <b>non-gain</b>&gt; OK, but if you don't accept my offer this time, I won't give you the free service-upgrade to "Gold".</p> <p>&lt;frame d – <b>loss</b>&gt; OK, but if you don't accept my offer this time, I'll charge you for the service-upgrade to "Gold".</p>	<p>Unit Price: \$2050/unit (39) Quantity: 200 units (3) Service Level: Gold (29) Delivery: 4 weeks (0)</p> <p>Total utility: (71)</p>

#### 4.4 The Dependent Variables and Moderating Variable

The subjective negotiation outcomes were evaluated using a post-negotiation questionnaire. Items were adapted from earlier negotiation experiments (e.g., [26, 27, 29, 44]) and the 16-item Subjective Value Inventory (SVI) that assesses subjective effectiveness [7]. The scales of this inventory are established and have shown good psychometric properties. The items for the key dependent variables are presented in Appendix A. The moderating variable, *Need for Cognition*, was assessed using the standard NC scale [9] (see Appendix B for sample items). This instrument was administered after participants completed the post-negotiation questionnaire.

#### 4.5 Procedure

The experiment followed a standard three-stage procedure. In the *pre-negotiation phase*, participants were assigned the role of a purchasing manager for a bogus buyer organization known as Tan Brothers Electronics Inc. They were given an information sheet describing the task and providing background information on the company, the terms of negotiation, and a utility table summarizing the range of possible utilities that could be obtained. Participants were not explicitly told the utilities associated with each term, but could identify and add the utilities themselves by referring to the utility table. The higher the utility score obtained, the higher the overall profitability of the negotiated agreement. Participants were reminded that utility scores in the top 30% would be eligible for a cash bonus. They then completed a pre-negotiation questionnaire to ensure that they properly understood the task.

In the *negotiation phase*, participants first entered a unique Buyer ID that was later used to retrieve their responses to offers from the server log. They then began their negotiation with the counterpart. There was no time limit for the negotiation. In each negotiation, participants (buyers) encountered up to four negotiation rounds. The first three rounds were identical across all conditions. The utility scores associated with them were constructed in such a way as to render offer acceptance unlikely. In the last round, all participants received offers with the same utility score—a score well above their (predefined) bottom lines (see Table 2 above).

In the *post-negotiation phase*, after the settlement, participants were asked to complete the post-negotiation questionnaire as well as the personality assessment items. Participants were then debriefed, given \$10 for their participation, and asked to keep their experience in the study confidential. The \$10 cash bonus awards (in fact for all participants) were announced (and in most cases, collected) four weeks later.

## 5 Data Analysis and Results

Before addressing the main hypothesis, we assessed the reliability of the subjective negotiation outcome measures. Results showed acceptable values with a Cronbach's alpha greater than 0.7 on all three dimensions—satisfaction with settlement, self, and counterpart (see Appendix A). In addition, because we measured NC after the framing manipulation, we had to confirm that NC scores were indeed a stable personality

difference and thus, not influenced by framing. Indeed, Need for Cognition scores did not differ as a function of frame conditions,  $F(3, 48) = .82, p = .49$ .

Three separate regression analyses were conducted with gain-loss frame, absence-presence frame and NC as predictors, and the subjective effectiveness measure of interest as the criterion variable in each analysis. In the first step, gain-loss frame, absence-presence frame, and centered NC scores were entered into the model. Following which, the interaction terms (i.e., gain-loss x absence-presence, NC x gain-loss, NC x absence-presence) were entered in the second step.

The analyses revealed *only* a 3-way interaction between NC, absence-presence frame, and gain-loss frame in *satisfaction with the counterpart*,  $B = -.03, t(44) = -1.80, p = .09$ . The interaction was decomposed by performing separate regression analyses for gain vs. loss frame, in terms of participants with low NC vs. high NC. The participants were categorized into those with NC scores one standard deviation below and one standard deviation above the mean respectively. Results showed that the 3-way interaction tended to be driven by low NCs experiencing less satisfaction with the counterpart after they accepted the non-gain frame as opposed to the other frames,  $B = .78, t(48) = 2.04, p = .05$ . For the high NCs, there were no significant differences in their satisfaction with counterpart in terms of efficiency among the four frames.

A similar pattern of result was also found for *satisfaction with the settlement*, i.e. a 3-way interaction between NC, absence-presence frame, and gain-loss frame,  $B = -.04, t(44) = -2.44, p < .05$ . When the interaction was decomposed in the same manner, results indicated that the interaction again was mainly driven by low NCs experiencing less satisfaction with the settlement after they accepted the non-gain frame as opposed to the other frames,  $B = .82, t(48) = 2.29, p < .05$ . There were also no significant differences in the satisfaction with the settlement for the high NCs across all frames.

The regression analysis revealed *only* a significant 2-way interaction between NC and absence-presence frame in *satisfaction with the self*,  $B = -.03, t(49) = -2.55, p < .05$ . The interaction was decomposed by performing separate regression analyses for participants with high NC versus those with low NC, again categorized by those with NC scores one standard deviation above and below the mean respectively. Results showed that among those high in NC, feelings about the self were more positive for those who accepted offers framed as *absences* (i.e. non-gain/non-loss) than for those who accepted offers framed as the *presence* of a gain or loss (i.e. gain/loss),  $B = -.34, t(49) = -2.05, p < .05$ . The reverse was found for participants low in NC, who tended to show more positive feelings about the self when they accepted the offer framed as the *presence* of a gain or loss (i.e. gain/loss) than when they accepted the offer framed as the *absence* of a gain or loss (i.e. non-gain/non-loss),  $B = .29, t(49) = 1.71, p = .09$ .

## 6 Discussion and Implications

### 6.1 Discussion

Our findings of no main effect indicate that there is no difference between offers framed as “promise” (gain/non-loss) versus those framed as “threat” (loss/non-gain) frames in any of the three dimensions of the subjective negotiation outcomes. Thus the prediction that promise (gain/non-loss) as opposed to threat (loss/non-gain) frames result in greater satisfaction with the counterpart (Hypothesis 1) and greater satisfaction with the settlement (Hypothesis 2) were not supported. Whether these predictions could be confirmed with a more sensitive design remains to be seen. However, interestingly, we observed a 3-way interaction among gain-loss, absence-presence frame, and NC on *satisfaction with the counterpart* and *satisfaction with the negotiation settlement*. That is, while high-NC negotiators were not affected by promise vs. threat, low-NC people tended to have less positive feelings about both the settlement and their counterpart (the seller agent) only after they accepted an offer presented in a *non-gain* frame. This suggests that the negative subjective consequence of issuing loss/non-gain frames was further coupled with the NC dimension. This may be due to the tendency that low-NC people feel less pleasant when they process the absence frame (i.e., non-gain). Therefore, between the two threat messages (loss and non-gain), the non-gain condition resulted in less positive subjective experience for the low-NC participants. Future research is needed to confirm this assertion.

Whereas Hypotheses 1 and 2 were not supported, there was support for Hypothesis 3 as evidenced by the absence/presence frame x NC interaction relative to *satisfaction with the self*. That is, participants high in NC were more satisfied with themselves after they accepted a non-gain/non-loss offer than a gain/loss offer, while those low in NC showed the opposite pattern. This result parallels the recent finding that perceived message complexity can impact processing of information among individuals who differ in NC. In particular, those high in NC reported greater motivational arousal and were more likely to use their background knowledge to process information, when they perceived a message as complex than when they perceived the same message to be simple. In contrast, individuals low in NC reported greater arousal and used their background knowledge (which was manipulated to be at the same level as the high NC individuals) when they perceived the same message as simple rather than when they perceived the message as complex [34].

### 6.2 Implications

The results of this work lend credence to the idea that framing and individual differences are worth taking into account in the design of intelligent negotiation agents. Our results show that negotiators had different preferences towards the same offer presented in different frames, depending on their level of NC. Negotiators high in NC felt better about themselves after accepting offers presented with complex non-gain/non-loss frames, whereas simple gain/loss frames elicited greater positive feelings about the self only for negotiators low in NC—a frame matching effect.

In the simplest manner, one plausible application of this finding in the context of agent-to-human negotiation would be to determine the human negotiators' level of NC prior to the negotiation by including the Need for Cognition Scale as a questionnaire that negotiators would complete as part of the procedure to create a user profile. Alternatively, designers could look into programming seller agents that could detect the human counterpart's NC by exploiting various behavioral manifestation of NC. For example, since high NC is associated with deeper information processing than low NC, the time taken for high NC negotiators to process an offer might be longer than for those low in NC. As such, real time measures such as the time taken for mouse movement during the online negotiation might be used to estimate of depth of processing, and thus the negotiator's level of NC. Agents might also attempt to assess NC by monitoring pre-negotiation behaviors such as the type of information (simple vs. complex) the human counterparts tend to select in pre-negotiation internet surfing. Once the information regarding negotiators' level of NC is obtained, frame matching can be applied by providing negotiators with offers framed in the way that matches their NC.

The advantage of using behavioral manifestations of NC is that they are more readily observable in an online setting, where agent-to-human negotiation typically takes place. The disadvantage, of course, is that they raise all kinds of difficult-to-resolve privacy and ethical questions.

## 7 Conclusion

In this paper we introduced a frame x personality perspective on agent-to-human negotiation. We demonstrated that unlike the traditional use of gain/loss framing in persuasion, which considers only the presence of gains and losses, the inclusion of the absence/presence dimension provides another important distinction in terms of the negation of gains and losses, that is, non-gains and non-losses. In particular, we established that in the context of individual differences in *Need for Cognition*, the traditional simple gain/loss frames fit the preferences of negotiators low in NC, whereas the more complex non-gain/non-loss frames fit the preferences of those who are high in NC. This interaction between the absence/presence dimension and need for cognition was found to impact negotiators' feelings about themselves, which is an important subjective negotiation outcome that can influence future negotiation choices.

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### Appendix A: Sample Items of the Post-Negotiation Questionnaire (adapted from [7, 26, 27, 29, 44])

Dependent Variables and Measurement items	Response options
<b><i>Satisfaction with the settlement</i></b>	
1. How satisfied are you with the outcome—i.e., the extent to which you expect the terms of your agreement (or lack of agreement) to benefit you?	1 = Not at all, 4 = Moderately, and 7 = Perfectly
2. How satisfied are you with the number of utility points you earned?	1 = Extremely dissatisfied, 4 = Indifferent, and 7 = Extremely satisfied
3. What do you think of the agreement?	1 = Much worse than I had hoped for, 4 = As expected, and 7 = Much better than I had hoped for
<b><i>Satisfaction with the self</i></b>	
1. Did you “lose face” (i.e., damage your sense of pride) in the negotiation? (Reverse coded)	1 = Not at all, 4 = Moderately, and 7 = A great deal; N.A.
2. Did this negotiation make you feel more or less competent as a negotiator?	1 = It made me feel less competent, 4 = It did not make me feel more or less competent, and 7 = It made me feel more competent;
3. Did you behave according to your own principles and values?	1 = Not at all, 4 = Moderately, and 7 = Perfectly; N.A.
4. Did this negotiation positively or negatively impact your self-image or your impression of yourself?	1 = It negatively impacted my self-image, 4 = It did not positively or negatively impact my self-image, and 7 = It positively impacted my self-image; N.A.
<b><i>Satisfaction with the counterpart</i></b>	
1. Do you feel the seller listened to your concerns?	1 = Not at all, 4 = Moderately, and 7 = Perfectly; N.A.
2. How satisfied are you with the ease (or difficulty) of reaching an agreement?	1 = Not at all satisfied, 4 = Moderately satisfied, and 7 = Perfectly satisfied
3. To what extent do you think the seller cared about your feelings?	1 = Not at all, 4 = Moderately, and 7 = Very much
4. To what extent do you think the seller cared about your interests and concerns?	1 = Not at all, 4 = Moderately, and 7 = Very much



## Appendix B: Sample Items of the Need for Cognition Scale [9]

Statements	Response options
I prefer complex to simple problems.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic
I would rather do something that requires little thought than something that is sure to challenge my abilities.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic
I find satisfaction in deliberating hard for long hours.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic
I really enjoy a task that involves coming up with new solutions to problems.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic
Learning new ways to think doesn't excite me much.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic
It's enough for me that something gets the job done; I don't care how or why it works.	1 = Extremely uncharacteristic, 3 = Uncertain, 5 = Extremely characteristic