The Effect of Expression of Anger and Happiness in Computer Agents on Negotiations with Humans

Celso M. de Melo
Institute for Creative Technologies, University of Southern California, 12015 Waterfront Drive, Building #4 Playa Vista, CA 90094-2536, USA
demelo@ict.usc.edu

Peter Carnevale
University of Southern California Marshall School of Business, Los Angeles, CA 90089-0808, USA
peter.carnevale@marshall.usc.edu

Jonathan Gratch
Institute for Creative Technologies, University of Southern California, 12015 Waterfront Drive, Building #4 Playa Vista, CA 90094-2536, USA
gratch@ict.usc.edu

ABSTRACT
There is now considerable evidence in social psychology, economics, and related disciplines that emotion plays an important role in negotiation. For example, humans make greater concessions in negotiation to an opposing human who expresses anger, and they make fewer concessions to an opponent who expresses happiness, compared to a no-emotion-expression control. However, in AI, despite the wide interest in negotiation as a means to resolve differences between agents and humans, emotion has been largely ignored. This paper explores whether expression of anger or happiness by computer agents, in a multi-issue negotiation task, can produce effects that resemble effects seen in human-human negotiation. The paper presents an experiment where participants play with agents that express emotions (anger vs. happiness vs. control) through different modalities (text vs. facial displays). An important distinction in our experiment is that participants are aware that they negotiate with computer agents. The data indicate that the emotion effects observed in past work with humans also occur in agent-human negotiation, and occur independently of modality of expression. The implications of these results are discussed for the fields of automated negotiation, intelligent virtual agents and artificial intelligence.

Categories and Subject Descriptors
I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence – *Intelligent Agents*; D.2.2 [**Software Engineering**]: Design Tools and Techniques – *User Interfaces*

General Terms
Design, Experimentation, Theory, Verification

Keywords
Negotiation, Emotion, Agent, Human, Empirical

1. INTRODUCTION
Recent research in the behavioral sciences has seen a growing interest on the impact of emotions in negotiation [1, 2]. On the one hand, research emphasizes the effect of felt emotion on one's own behavior [3, 4, 5, 6, 7]. On the other hand, research emphasizes the effect of *expressed* emotion on another's behavior. This interpersonal effect of emotion is in line with the view that emotions serve important social functions and convey information about one's beliefs, desires and intentions [8, 9, 10, 11]. For example, many studies demonstrate that displaying anger in a negotiation often triggers greater concession-making in one's opponent [12, 13, 14], whereas displaying happiness leads to fewer concessions [12]. The argument is that anger (or happiness) conveys information about the opponent's high (or low) aspirations in the negotiation [12, 13]. Thus, when faced with an angry opponent, one has to lower one's demands to reach an agreement. In turn, when faced with a happy opponent, one can afford to be strategically more demanding. However, despite the wide interest the artificial intelligence community has shown in modeling (or automating) negotiation for the purpose of resolving conflict in agent-agent or human-agent interactions [15, 16, 17], emotion has been notoriously absent in these models.

Many negotiation models in artificial intelligence draw on earlier work from game theory [18, 19, 20, 21, 22, 23]. These models attempt to address some of the limitations in game theory such as the assumption of perfect computational rationality (i.e., there is no cost to search the whole space of possible solutions to find the optimal solution), the infinite time horizon (i.e., time has no cost) and the assumption of complete information (i.e., the agent knows its own preferences as well as the opponent's). In real-life some or all of these assumptions are unreasonable. To address these issues, theoretical extensions of early game theory work have been proposed, and heuristics and learning were integrated into negotiation models: Fatima et al. [24] propose an agenda-based framework for multi-issue bargaining under time constraints in an incomplete information setting; Hindriks and Tykhonov [25], extending earlier work by Zeng and Sycara [26], propose a solution for learning the opponent's preferences and issue priorities in multi-issue negotiation using Bayes rule; Sycara [27] combines case-based reasoning with multi-attribute utility theory to address multi-issue bargaining; Luo et al. [28] proposes a fuzzy-constraint model for bilateral multi-issue bargaining; Faratin et al. [29] suggests trading off on multiple issues (or logrolling [30]) based on similarity criteria; and, Lai and Sycara [31] suggest a distance-based heuristic for trading off issues. However, despite acknowledging the need for bounded rationality [32], these models are much more prescriptive than descriptive of

Cite as: The Effect of Expression of Anger and Happiness in Computer Agents on Negotiations with Humans, Celso de Melo, Peter Carnevale and Jonathan Gratch, *Proc. of 10th Int. Conf. on Autonomous Agents and Multiagent Systems – Innovative Applications Track (AAMAS 2011)*, Tumer, Yolum, Sonenberg and Stone (eds.), May, 2–6, 2011, Taipei, Taiwan, pp. 937 - 944.

human behavior. Effectively, it is now widely accepted that people are not strictly concerned with maximizing expected utility and do not always follow theoretical equilibrium strategies [33, 34, 35, 36]. As a result, these systems tend to be optimized for agent-agent interaction.

Several systems in artificial intelligence focus explicitly on human-agent negotiation and simulate behavior humans do in real negotiations [17]. Kraus and Lehmann [37] developed the Diplomat agent that behaves according to different 'personalities' and has a learning mechanism to learn the personality of its opponents. The agent also has a randomization mechanism that, according to its personality, determines whether agreements will be breached or fulfilled. Because agreements become unenforceable, trust becomes an issue in human-agent negotiation, similarly to human-human negotiation [38]. Byde [39] has developed a negotiation agent that supports 'cheap talk' [40], i.e., the proposition of offers which cannot be validated by the other party a priori. Katz and Kraus [41] propose an agent which behavior in the ultimatum game follows a heuristic based on the qualitative theory of Learning Direction [42]. Gal et al. [43] propose a learning mechanism that learns a model of human social preferences and this model is then used to predict the reaction of the opponent to the agent's offers. Lin et al. [44] propose an agent that also tries to learn which 'type' of opponent it is playing with and, rather than focusing on maximizing expected utility, uses a more qualitative approach for decision-making. However, though being closer to supporting the kind of negotiation we see in real-life between humans, these systems still don't address the pervasive role emotion plays in decision-making [33, 45]. In particular, none addresses the effect that expression of emotion has on negotiation outcome [1, 12, 13, 14].

In this work, we're interested on the impact expression of anger and happiness has on negotiation outcome. Van Kleef et al.'s [12, 46] seminal study describes a computer-mediated multi-issue negotiation scenario, where participants face an opponent that expresses anger, happiness or nothing (control). Participants are carefully led to believe they are negotiating with another participant, through a computer, but in fact they are matched with a computer program that plays a scripted strategy. Participants are instructed that they were randomly chosen to have access to a report of the opponent's intentions, without the opponent knowing about it, and that the opponent was randomly chosen not to have access to the participants' intentions. So, on rounds 1, 3 and 5, the opponent (i.e., the computer program) supposedly reports, textually, that it is happy or angry with the participant's last offer. Participants are not told how many rounds the negotiation takes, except that it is finite horizon, and the negotiation always ends on round 6. Results show that participants concede more - i.e., the offer in round 6 is worth less for the participant – when matched with the angry opponent than the control and, participants concede less when matched with the happy opponent than the control. Based on results from a follow-up experiment [12], they argue that participants are using emotion to infer the opponent's limits. So, when faced with an angry opponent, they estimate the opponent to have high limits and, thus, to avoid costly impasse, they make large concessions. When faced with a happy opponent, they infer the opponent to have low limits and, thus, strategically make low concessions. Steinel et al. [47] go a bit further and show that this effect only occurs when emotions are directed at the offers but not when directed at the person. Whereas these studies relied on verbal expression of emotion, similar results have been obtained when emotion is conveyed through pictures of facial expressions [13] and when participants are instructed to act angry or happy in face-to-face negotiation [14]. In all these experiments, however, there was particular care to create the impression on the participants that they were interacting with other participants. In contrast, in this work we're interested in learning whether expression of emotion will have an impact on negotiation when people know they're negotiating with computer agents. Additionally, this work also explores the impact of verbal and non-verbal expression of emotion in negotiation with computer agents. Whether the effect in human-human negotiation carries to human-agent negotiation is not obvious. It has been shown in the past that knowledge of whether the opponent is a computer program or not can have an impact on the interaction. For instance, Sanfey [48] showed that people treat differently unfair offers made by humans than by computer programs in an ultimatum game and, Grossklags and Schmidt [49] showed that people play differently when they are aware of the presence of computer agents in a double auction market environment. However, Nass and colleagues [50, 51] propose the view that *computers are social actors* based on evidence that individual's interactions with computers are fundamentally social and that people unconsciously treat human-machine interaction in the same way as human-human interaction. When applied to computer agents that express emotions, this view should predict that the impact of emotion in human-agent interaction should be similar to the effect in human-human interaction.

This paper describes an experiment where participants are engaged in a multi-issue bargaining task with computer agents that express emotions verbally (through text) and non-verbally (through animated facial expressions). The experiment follows a factorial design with two between-participants factors: *Emotion* (Angry vs. Happy vs. Control); and, *Modality of Expression* (Verbal vs. Non-Verbal). Participants are explicitly instructed that they'll be negotiating with computer agents. Our hypotheses are that, similarly to the predictions from the behavioral sciences literature regarding human-human negotiation and in line with the view that computers are social actors, participants will concede more with an angry agent than the control and, concede less with a happy agent than the control. Moreover, we expect these results to occur independently of modality of expression.

2. EXPERIMENT

The experiment closely follows the design in the studies described above [1, 12, 13, 14, 46].

Negotiation Task. . Participants play the role of a seller of a consignment of mobile phones whose goal is to negotiate three issues: the price, the warranty period and the duration of the service contract of the phones. Each issue has 9 levels, being the highest level the most valuable for the participant, and the lowest level the least valuable [1]. Level 1 on price ($110) yields 0 points and level 9 ($150) yields 400 points (i.e., each level corresponds

[1] This contrasts with Van Kleef et al.'s study [12] which defines the lowest (highest) level to be the most (least) valuable for the participant. However, a pilot study we did suggested that defining the lowest (highest) level to be the least (most) valuable is a better match to participants' intuitions.

to a 50 point increment). Level 1 on warranty (9 months) yields 0 points and level 9 (1 month) yields 120 points (i.e., each level corresponds to a 15 point increment). Finally, for duration of service contract, level 1 (9 months) yields 0 points, and level 9 (1 month) yields 240 points (i.e., each level corresponds to a 30 point increment). It is pointed out to the participant that the best deal is, thus, 9-9-9 for a total outcome of 760 points (400 + 120 + 240). The participant is also told that the agent has a *different* payoff table which is not known. The negotiation proceeds according to the alternating offers protocol [52], being the agent the first to make an offer. Finally, the participant is informed that the negotiation will proceed until one player accepts the offer or time expires. If no agreement is reached by the end of round 6, negotiation is always terminated [12], but participants are not aware of how many rounds the negotiation lasts a priori.

Incentive Structure. The incentive to participate follows standard practice in experimental economics [53]: first, participants are given school credit for their participation; second, with respect to their goal in the game, participants are explicitly instructed to earn as many points as possible, as the total amount of points would increase their chance of winning a lottery for $100. Importantly, they are told they would *not* get any points if they fail to reach an agreement.

Agent's Offers. Agents in every condition follow the same scripted sequence of offers (level on price, level on warranty, level on service): 2-3-2, 2-3-3, 2-4-3, 3-4-3, 3-4-4, and 4-4-4. This is the same sequence as in Van Kleef et al.'s experiment, where it is argued to strike the right balance of cooperation and competition [12].

Conditions. The experiment follows a 2x3 factorial design with the following independent variables: *Emotion* (Angry vs. Happy vs. Control); and, *Modality of Expression* (Verbal vs. Non-Verbal). In the emotion conditions, for both modalities, the agent will express the emotion after the participant makes an offer on rounds 1, 3 and 5. The timing of the expression is as follows: (1) the participant makes an offer; (b) 3 seconds later, the agent will express an emotion (unless it's one of the control conditions); (c) 5 seconds later, the agent makes a counter-offer; (d) 1 second later, the participant is allowed to make another offer or accept the agent's offer; (e) after the participant counter-offers or accepts the offer, the expression fades out. This timing aims to achieve two things: (1) by having the expression immediately follow the participant's offer, make sure participants perceive the target of the emotion to be the offer and not the person [47]; (2) give enough time for the participant to perceive the expression before making another offer.

In the verbal case, emotion is expressed through text. The sentences are similar to the ones used in the original Van Kleef et al. experiment [12]: (a) for the angry case they are (in order): "This is a ridiculous offer, it really pisses me off", "I am starting to get really angry" and "All this is starting to get really irritating"; (b) for the happy case they are: "This is going pretty well, I can't complain", "I like the way things are going, I can only be happy with this" and "I am pretty satisfied with this negotiation"; (c) for the control case, they are: "Here is my counter-offer", "Here's my next offer" and "Here is my offer". To increase realism, text typing of the sentences is simulated: a blinking prompt leads the text as it is typed and letters are typed at varying speed.

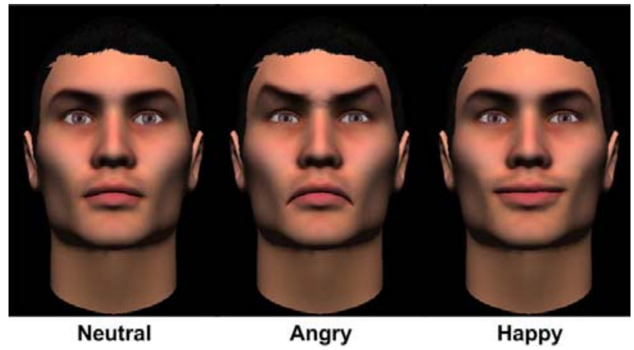

Figure 1. The facial displays of emotion.

In the non-verbal case, emotion is expressed through facial displays. The facial displays used in this experiment are shown in Figure 1. Facial displays are animated using a real-time pseudo-muscular model for the face that also simulates wrinkles in the region between the eyebrows for anger [54]. All facial displays have been previously validated [55].

Measures. Our main dependent variable is *demand difference* between demand level in round 1 (initial offer) and round 6 (final offer). To calculate demand level, the number of points demanded in each round is summed across all issues of price, warranty and service. Demand difference is then calculated by subtracting demand level in round 1 (first offer) and demand level in round 6 (last offer).

After the negotiation, participants filled a questionnaire that contained manipulation checks. To check that participant's perceived the emotion the agent was suppose to be expressing, we ask the following six classification questions (scale goes from 1 – 'not at all' to 7 – 'very much'):

- How much do you believe the agent experienced ANGER / HAPPINESS?
- How SATISFIED / IRRITATED / BAD-TEMPERED / PLEASED do you believe the agent was?

Finally, to validate that participants are interpreting the emotions to be directed at the offer and not the person, we ask two questions, on a 1 (meaning 'not at all') to 7 (meaning 'very much') scale:

- How much do you think the agent's emotions were directed at YOU / YOUR OFFERS?

Software. The negotiation task and questionnaires were implemented in software. Figure 2 shows the software when emotion is expressed non-verbally. In the verbal case, text appears on the upper part of the region where the face would be.

Quiz and Tutorial. To make sure the instructions were understood, participants first take a quiz where they are asked questions about interpretation of offers (e.g., "How many points would YOU get if you were given an offer of 1-1-1?"), value of their offers to the participants ("If you offer 9-9-9, how much is that worth to the other player?") and incentive structure ("How many points would you get if you don't reach an agreement?"). Participants are only allowed to proceed once they've provided the correct answers to the questions. After finishing the quiz, participants play a tutorial negotiation session with an agent that

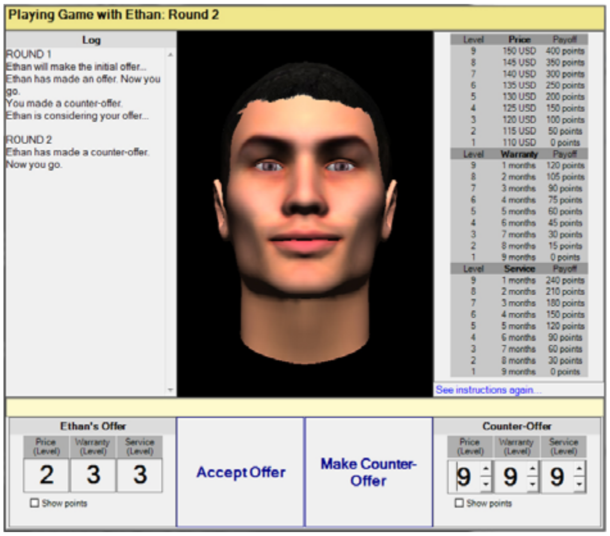

Figure 2. The software used in the experiment.

follows a scripted sequence of offers: 1-1-1, 2-2-2…9-9-9. This tutorial allows participants to get acquainted with the task and software interface. Upon completion of the tutorial, participants proceed to play the actual negotiation task.

Participants and Procedure. One-hundred and fifty (150) participants were recruited for this experiment at our University's business school student pool. Most participants were undergraduate (50.0%) or graduate (48.0%) students majoring in diverse fields. Average age was 22.8 years and 63% were males. Most were originally from Asia (60.0%) and North America (37.3%).

The experiment was organized into sessions where 13 participants play the negotiation task at the same time. Upon arrival, participants were greeted by the experimenter and seated in their computer cubicle. After signing a consent form, participants were allowed to start the experiment immediately, which was fully implemented in software. Because we were running many participants in parallel and not every session filled, we did not get the same amount of participants for each of the 6 conditions but, every condition always had between 24 and 27 participants.

3. RESULTS

In order to compare our results with Van Kleef and colleagues; studies, we use the same exclusion criterion [1, 12, 13, 14, 46], i.e., any participant that reached agreement before round 6 was excluded. The argument is that participants that reach agreement before round 6 are likely not taking the negotiation seriously [12, 46]. After applying this criterion, 24 participants were excluded out of 150.

3.1 Manipulation Checks

The classification questions for perception of anger, irritation and bad-temperament were averaged as their results were found to be highly correlated (α=.866). We ran a factorial ANOVA on this anger index with 2 between-participants factors: Emotion (Angry vs. Happy vs. Control); and, Modality (Verbal vs. Non-Verbal). Results revealed a main effect of Emotion, $F(2, 120) = 29.166$, $p<.001$. The Tukey *post hoc* test revealed that the Angry agents (verbal: M=5.02, SD=1.71; non-verbal: M=5.09, SD=1.31) were perceived to be angrier than the Happy (verbal: M=2.42, SD=1.19; non-verbal: M=2.96, SD=1.43) and Neutral (verbal: M=3.73, SD=1.32; non-verbal: M=3.80, SD=1.70) agents ($p<.001$ in both cases). The classification questions for perception of happiness, satisfaction and pleasantness were also averaged as their results were highly correlated (α=.841). We also ran a two-way factorial ANOVA on the happiness index with Emotion and Modality as between-participants factors. Results revealed a main effect of Emotion, $F(2, 120) = 13.263$, $p<.001$. The Tukey *post hoc* test revealed that the Happy agents (verbal: M=3.89, SD=1.49; non-verbal: M=2.85, SD=1.49) were perceived to be happier than the Angry (verbal: M=2.04, SD=1.00; non-verbal: M=2.19, SD=.97) and Neutral (verbal: M=2.47, SD=1.22; non-verbal: M=2.15, SD=.89) agents ($p<.001$ in both cases). In summary, participants perceived as expected the Angry agents to be angrier than the others and the Happy agents to be happier than the others.

Regarding target of emotion, we compared using a *dependent-measures t-test* the classification questions about whether the target was the offer or the participant. Results revealed, as expected, that participants perceived the target of expressed emotion to be significantly more the offers (M=4.57, SD=1.74) than the participant (M=3.15, SD=1.60, $t(125)$=-7.252, $p<.001$).

3.2 Demand Difference

Demand difference was analyzed using a factorial ANOVA with 2 between-participants factors: Emotion (Angry vs. Happy vs. Control); and, Modality (Verbal vs. Non-Verbal). There was no main effect of Modality on demand difference, $F(1, 120)$=.767, p=.383>.05. This means that, on average, participants conceded as much with text as face agents, when collapsing across emotions. There was a significant main effect of Emotion on demand difference, $F(2, 120)$=6.578, $p<.01$. The Tukey *post-hoc* test revealed that demand difference was: (a) lower with Happy agents than with Angry agents ($p<.01$); (b) tended to be lower with Happy agents than the Control agents (p=.157); (c) tended to be higher with the Angry agents than the Control agents (p=.159). This suggests that, in line with Van Kleef et al. studies, participants are conceding more with the Angry agents than the Control agents and, conceding less with the Happy agents than the Control agent. Finally, there was no significant interaction between Modality and Emotion, $F(2, 120)$=.602, p=.550>.05. Additionally, comparing demand difference across modalities using an *independent t-test* shows no significant differences for the Happy ($t(38)$=-.291, p=.773>.05), Angry ($t(39)$=1.083, p=.285>.05) or Control agents ($t(43)$=.611, p=.545>.05). This suggests that emotion is having the same impact on demand difference independently of modality of expression. Figure 3 summarizes average demand difference for each condition and Table 1 shows averages, standard deviations and Ns for demand difference in each condition.

4. DISCUSSION

The results show that people concede more to an agent that expresses anger than to one that expresses happiness. The results also show clear trends that people concede more to an angry agent than to the control agent that shows no emotion and concede less to a happy agent than to the control agent. These results are in line with the predictions from Van Kleef and colleagues on the impact of expression of emotion in human-human negotiation [1, 12, 13, 14, 46]. According to this theory, people use emotion to infer the opponent's limits. So, when faced with an angry opponent, they estimate the opponent to have high limits and, thus, to avoid costly impasse, make large concessions. When faced with a happy opponent, people infer the opponent to have low limits and, thus, strategically make low concessions. Our results emphasize that this effect also occurs when people are involved in a negotiation with computer agents.

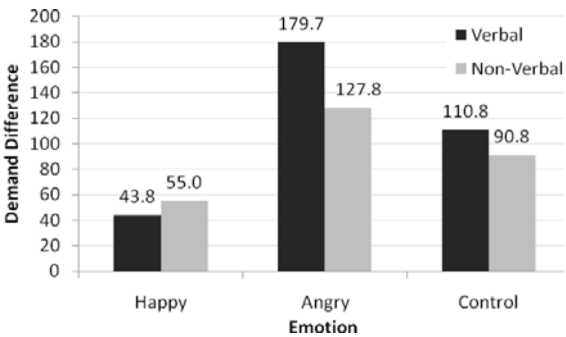

Figure 3. Demand difference between rounds 1 and 6 for each condition.

Table 1. Descriptive statistics for demand difference between rounds 1 and 6 in each condition

Modality	Emotion	N	Mean	Std. Dev.
Verbal	Happy	24	43.750	128.090
	Angry	18	179.722	164.554
	Control	20	110.750	115.716
	Total	*62*	*104.839*	*145.044*
Non-Verbal	Happy	16	55.000	105.657
	Angry	23	127.826	141.941
	Control	25	90.800	103.135
	Total	*64*	*95.156*	*120.633*
Total	Happy	40	48.250	118.325
	Angry	41	150.610	152.542
	Control	45	99.667	108.095
	Total	*126*	*99.921*	*132.757*

The results have important implications for the design of computer agents that can negotiate with people. Whereas artificial intelligence research in automated negotiation has tended to focus on structural aspects of negotiation [15, 16, 17] – how many parties are involved, how many issues are being negotiated, how to schedule an agenda for the issues, whether the negotiation is one-shot or multiple iterations, and so on – the present results emphasize it is also relevant to consider the broader social context of human-agent negotiation. Effectively, research in the behavioral sciences has already shown that personality [56], culture [57], social context [58] and, in particular, expressions of emotion impacts negotiation [1]. In computer science, Nass and colleagues' [50, 51] view that computers are social actors points out that people unconsciously treat human-machine interaction in the same way they do human-human interaction. Several recent studies have started exploring whether the influence of affect we see in human-human interaction also impacts human-machine interaction [59]. In particular, some studies explore the impact of emotion on negotiation or, more generally, decision-making: Traum et al. [60] propose a broad negotiation model for multi-party multi-issue negotiation where agents can follow different strategies – find issue, avoid, attack, advocate, etc. – and signal these strategies with heuristic gestures (e.g., defensive crossed-arms for the avoid strategy); Gong [61] shows that people tend to trust agents that express positive emotions more than negative emotions, even when the emotions are independent of context; Brave et al. [62] show that people trust agents that display other-oriented empathic emotion more than agents that display self-oriented empathic emotion; and, recently, we have shown that display of appropriate emotions can promote emergence of cooperation between humans and agents [55, 63]. The experiment presented in this paper adds empirical evidence that display of anger and happiness can have an impact in negotiation between agents and humans.

The results also suggest that verbal and non-verbal expression of anger and happiness in this negotiation task produce similar effects. This is consistent with findings in the behavioral sciences that show compatible effects of anger when expressed through text [12], pictures of faces [13] or in face-to-face negotiation [14]. However, even though textual and facial display of anger and happiness are producing similar effects in this negotiation task, we're not claiming that verbal and non-verbal expression of emotion always produce the same effect in negotiation. Effectively, it has been shown before that text-based negotiation can be different from face-to-face negotiation [64]. Moreover, it has been argued that non-verbal expression of emotion conveys information that is hard to convey through text: non-verbal cues may intensify or tone down the emotion expression [65]; non-verbal cues tend to occur unconsciously, in contrast to textual expression of emotion (e.g., emoticons [66]); and, building rapport relies heavily on mimicry of non-verbal aspects [67]. Therefore, further work is necessary to clarify when does verbal or non-verbal expression of emotion produce similar or different effects in negotiation.

In this paper we focus on anger and happiness, however, it has been shown that other emotions can also impact negotiation outcome. Thompson et al. [68] show that when opponents show disappointment (vs. happiness) after a negotiation, people perceive the negotiation to have been more successful. Van Kleef et al. [69] also explored the impact of emotions of supplication (disappointment and worry) and appeasement (guilt and regret) on concession level. Results indicate that people concede more to a supplicating opponent than a control agent, and concede less to a guilty opponent. Following our results, we expect these findings to replicate also in human-agent interactions. Power has also been shown to mediate the effect of emotion on negotiation outcome [70]. For instance, results indicate that high-power individuals do not lower (raise) their demand when faced with an angry (happy) opponent [14, 46]. Whether this mediating role of power on expression of emotion also occurs in human-agent interaction is also a topic of future work but, once again, we expect results to replicate the findings in the aforementioned studies. Finally, this work focuses on the impact of anger and happiness in one-shot negotiations. If agents only interacted once with any particular human, it would be tempting to suggest the agent designer to make the agent always angry, since, at least if it is not the case that the human has more power than the agent, this leads to higher concession from the human. However, people more often than not negotiate with people they've negotiated before. Therefore, being able to maintain a good relationship with the other negotiator is usually important [71]. It has also been argued that maintaining relations with agents is important for effective long-term human-agent interaction [72]. So, what is the long-term impact of having an agent express anger or happiness? Recent research by Van Kleef et al. [73] suggests that if participants engage in sequential negotiation tasks, similar to the one explored here, with a person that conveys anger in the first task but not in the second, people will tend to perceive this person as tough and continue to concede (as opposed to retaliate) in the second task. Notice, however, that participants are not given a choice to play (or not) the second task with the angry agent. Nevertheless, the results suggest what to expect when people interact multiple times with the same agent that expresses anger. Still, further research is required to understand the long-term impact of expression of happiness and, importantly, what happens if the participant has the choice to play or not the second game with the emotional agent.

Finally, we plan (and have begun) to explore contingent displays of emotion. In this work, following the literature in the behavioral sciences, we start by exploring non-contingent display of anger and happiness, i.e., no matter what the participant offers, the agent will always display the same emotion. However, non-contingent display of emotions is at odds with appraisal theories of emotion [73]. Appraisal theories argue that emotion arises from cognitive appraisal of events with respect to one's goals, desires and beliefs (e.g., is this event congruent with my goals? Who is responsible for this event? Do I have control over this event?). According to the pattern of appraisals, different emotions ensue. So, if people perceive anger when they made a bad offer, they can infer that the opponent does not like the offer and is blaming them for that. However, what does it mean when the opponent expresses anger and the offer was good? Recent work in both the behavioral sciences [74] and computer science [55] suggest that people can infer different things from the same emotion display, i.e., the context in which the emotion is expressed is critical to its interpretation. Thus, further research is necessary to understand whether contingent display of appropriate emotion at the right time in negotiation produces different effects (in quality and/or intensity) on negotiation outcome when compared to non-contingent display of emotion.

5. ACKNOWLEDGMENTS

This work was sponsored by the Fundação para a Ciência e a Tecnologia (FCT) grant #SFRH-BD-39590-2007 and, the U.S. Army Research, Development, and Engineering Command and the National Science Foundation under grant #HS-0713603. The content does not necessarily reflect the position or the policy of the Government, and no official endorsement should be inferred.

6. REFERENCES

[1] Van Kleef, G., De Dreu, C., and Manstead, A. 2010. An interpersonal approach to emotion in social decision making: The emotions as social information model. Advances in Experimental Social Psychology 42: 45-96.

[2] Barry, B., Fulmer, I., and Goates, N. 2006. Bargaining with feeling: Emotionality in and around negotiation. In: L. Thompson (ed.), Negotiation Theory and Research, 99-127. New York: Psychology Press.

[3] Carnevale, P., Isen, A. 1986. The influence of positive affect and visual access on the discovery of integrative solutions in Bilateral negotiation. Organizational Behavior Human Performance 37:1–13.

[4] Isen, A. 1987. Positive affect, cognitive processes and social behavior. Advances in Experimental Social Psychology 20: 203–253.

[5] Baron, R., Fortin, S., Frei, R., Hauver, L., and Shack, M. 1990. Reducing organizational conflict: The role of socially-induced positive affect. International Journal of Conflict Management 1, 133-152.

[6] Allred, K., Mallozzi, J., Matsui, F., and Raia, C. P. 1997. The influence of anger and compassion on negotiation performance. Organizational Behavior and Human Decision Processes 70, 175–187.

[7] Forgas, J. 1998. On feeling good and getting your way: Mood effects on negotiator cognition and behavior. Journal of Personality and Social Psychology 74, 565–577.

[8] Frijda, N., Mesquita, B. 1994. The social roles and functions of emotions. In: S. Kitayama, H. Markus (eds.), Emotion and culture: Empirical studies of mutual influence, 51–87, American Psychological Association.

[9] Keltner, D., Haidt, J. 1999. Social functions of emotions at four levels of analysis. Cognition and Emotion 13: 505–521.

[10] Keltner, D., Kring, A. 1998. Emotion, Social Function, and Psychopathology. Review of General Psychology 2(3): 320–342.

[11] Morris, M., Keltner, D. 2000. How emotions work: An analysis of the social functions of emotional expression in negotiations. Research in Organizational Behavior, 22, 1–50.

[12] Van Kleef, G., De Dreu, C., and Manstead, A. 2004. The interpersonal effects of anger and happiness in negotiations. Journal of Personality and Social Psychology 86: 57–76.

[13] Pietroni, D., Van Kleef, G., De Dreu, C., and Pagliaro, S. (2008). Emotions as strategic information: Effects of other's emotions on fixed-pie perception, demands and integrative behavior in negotiation. Journal of Experimental Social Psychology 44: 1444–1454.

[14] Sinaceur, M., Tiedens, L. 2006. Get mad and get more than even: When and why anger expression is effective in negotiations. Journal of Experimental Social Psychology 42: 314–322.

[15] Jennings, N., Faratin, P., Lomuscio, A., Parsons S., Wooldridge, M., and Sierra, C. 2001. Automated Negotiation: Prospects, Methods and Challenges. Group Decision and Negotiation 10(2): 199-215.

[16] Sycara, K., Dai, T. 2010. Agent Reasoning in Negotiation. In: D. Kilgour, C. Eden (eds.), Handbook of Group Decision and Negotiation, 437-451, Springer Netherlands.

[17] Lin, R., Kraus, S. 2010. Can Automated Agents Proficiently Negotiate with Humans? Communications of the ACM 53(1): 78-88.

[18] Von Neumann, J., Morgenstern, O. 1944. The Theory of Games and Economic Behaviour. Princeton University Press.

[19] Nash, J. 1950. The bargaining problem. Econometrica 18:155–162.

[20] Kalai, E. 1977. Proportional solutions to bargaining situations: intertemporal utility comparisons. Econometrica 45:1623–1630.

[21] Bac, M., Raff, H. 1996. Issue-by-issue negotiations: the role of information and time preference. Games Economic Behavior 13:125–134.

[22] Busch, L., Horstmann, I. 1999. Signaling via an agenda in multi-issue bargaining with incomplete information. Economic Theory 13:561–575.

[23] Lang, K., Rosenthal. R. 2001. Bargaining piecemeal or all at once. Economic Journal 111:526–540.

[24] Fatima, S., Wooldridge, M., and Jennings, N. 2004. An agenda-based framework for multi-issue negotiation. Artificial Intelligence 152:1–45.

[25] Hindriks, K., Tykhonov, D. 2008. Opponent Modelling in Automated Multi-Issue Negotiation Using Bayesian Learning. Proceedings of Autonomous Agents and Multi-Agent Systems 2010, 331-338.

[26] Zeng, D., Sycara, K. 1998. Bayesian Learning in Negotiation, International Journal of Human Computer Systems 48: 125-141.

[27] Sycara, K. 1990. Negotiation planning: an AI approach. European Journal Operational Research 46:216–234.

[28] Luo, X., Jennings, N., Shadbolt, N., Leung, H., and Lee, J. 2003. A fuzzy constraint based model for bilateral multi-issue negotiations in semi-competitive environments. Artificial Intelligence 148:53–102.

[29] Faratin, P., Sierra, C., and Jennings, N. 2002. Using similarity criteria to make issue trade-offs in automated negotiations. Artificial Intelligence 142:205–237.

[30] Carnevale, P. 2006. Creativity in the outcomes of conflict. In: M. Deutsch, P. Coleman, E. Marcus (eds.), Handbook of conflict resolution – 2 edn, 414-435, Jossey-Bass.

[31] Lai, G. Sycara, K. 2009. A Generic Framework for Automated Multi-attribute Negotiation. Group Decision Negotiation 18: 169-187.

[32] Simon, A. 1982. Models of Bounded Rationality, Volume 2. MIT Press.

[33] Loewenstein, G., Lerner, J. 2003. The role of affect in decision making. In: Davidson, R.J., Scherer, K.R., Goldsmith, H.H. (eds.), Handbook of Affective Sciences, 619-642, Oxford University Press.

[34] Erev, I., Roth, A. 1998. Predicting how people play games: Reinforcement learning in experimental games with unique, mixed strategy equilibrium. American Economic Review 88(4): 848–881.

[35] McKelvey, R., Palfrey, T. 1992. An experimental study of the centipede game. Econometrica 60(4): 803–836.

[36] Tversky, A., Kahneman, D. 1981. The framing of decisions and the psychology of choice. Science 211: 453–458.

[37] Kraus, S., Lehmann, D. 1995. Designing and building a negotiating automated agent. Computational Intelligence 11(1): 132–171.

[38] Ross, W., LaCroix, J. 1996. Multiple meanings of trust in negotiation theory and research: A literature review and integrative model. International Journal of Conflict Management 7(4): 314–360.

[39] Byde, A., Yearworth, M., Chen, Y.-K., and Bartolini, C. 2003. AutONA: A system for automated multiple 1-1 negotiation. In Proceedings of the 2003 IEEE International Conference on Electronic Commerce, 59–67.

[40] Farrell, J. Rabin, M. 1996. Cheap talk. Journal of Economic Perspectives 10(3): 103–118.

[41] Katz, R., Kraus, S. 2006. Efficient agents for cliff-edge environments with a large set of decision options. In Proceedings of the 5th International Conference on Autonomous Agents and Multi-Agent Systems, 697–704.

[42] Selten, R., Stoecker, R. 1986. End behavior in sequences of finite prisoner's dilemma supergames: A learning theory approach. Econ Behavior and Organization 7(1): 47–70.

[43] Gal, Y., Pfeffer, A., Marzo, F. and Grosz, B. 2004. Learning social preferences in games. In Proceedings of the National Conference on Artificial Intelligence, 226–231.

[44] Lin, R., Kraus, S., Wilkenfeld, J. and Barry, J. 2008. Negotiating with bounded rational agents in environments with incomplete information using an automated agent. Artificial Intelligence 172(6–7): 823–851.

[45] Blanchette, I., Richards, A. 2009. The influence of affect on higher level cognition: a review of research on interpretation, judgment, decision making and reasoning. Cognition & Emotion, 1-35.

[46] Van Kleef, G., De Dreu, C., and Manstead, A. 2004. The interpersonal effects of emotions in negotiations: A motivated information processing approach. Journal of Personality and Social Psychology 87: 510-528.

[47] Steinel, W., Van Kleef, G. A., and Harinck, F.2008. Are you talking to me?! Separating the people from the problem when expressing emotions in negotiation. Journal of Experimental Social Psychology 44: 362-369.

[48] Sanfey, A., Rilling, J., Aronson, J., Nystrom, L., and Cohen, J. 2003. The neural basis of economic decision making in the ultimatum game. Science 300: 1755–1758.

[49] Grossklags, J., Schmidt, C. 2006. Software agents and market (in) efficiency: a human trader experiment. IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews 36(1): 56–67.

[50] Nass, C., Steuer, J., and Tauber, E. 1994. Computers are social actors. In Proceedings of SIGCHI 1994, 72-78.

[51] Reeves, B., Nass, C. 1996. The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places. University of Chicago Press.

[52] Rubinstein, A. 1985. A bargaining model with incomplete information about preferences. Econometrica 53(5): 1151–1172.

[53] Hertwig, R., Ortmann, A. 2001. Experimental practices in economics: A methodological challenge for psychologists? Behavioral and Brain Sciences 24: 383-451.

[54] de Melo, C., & Gratch, J. 2009. Expression of Emotions using Wrinkles, Blushing, Sweating and Tears. In Proceedings of the Intelligent Virtual Agents 2009, 188-200.

[55] de Melo, C., Carnevale, P., and Gratch, J. 2010. The influence of Emotions in Embodied Agents on Human Decision-Making. In Proceedings of Intelligent Virtual Agents 2010, 357-370.

[56] Barry, B., Friedman, R. 1998. Bargainer characteristics in distributive and integrative negotiation. Journal of Personality and Social Psychology 74: 345-59.

[57] Leung, K., Bhagat, R., Buchan, N., Erez, M., and Gibson, C. 2005. Culture and international business: recent advances and their implications for future research. Journal of International Business Studies 36: 357-378.

[58] Druckman, D. 1994. Determinants of Compromising Behavior in Negotiation: A Meta-Analysis. The Journal of Conflict Resolution 38(3): 507-556.

[59] Beale, R. Creed, C. 2009. Affective interaction: How emotional agents affect users. Human-Computer Studies 67: 755–776.

[60] Traum, D., Marsella, S., Gratch, J., Lee, J., and Hartholt, A. 2008. Multi-party, multi-issue, multi-strategy negotiation for multi-modal virtual agents. In Proceedings of Intelligent Virtual Agents Conference 2008, 117-130.

[61] Gong, L. 2007. Is happy better than sad even if they are both non-adaptive? Effects of emotional expressions of talking–head interface e-agents. Journal of Human–Computer Studies 65(3): 183–191.

[62] Brave, S., Nass, C., and Hutchinson, K. 2005. Computers that care: investigating the effects of orientation of emotion exhibited by an embodied computer agent. Journal of Human–Computer Studies 62(2): 161–178.

[63] de Melo, C., Zheng, L., and Gratch, J. 2009. Expression of Moral Emotions in Cooperating Agents. In Proceedings of Intelligent Virtual Agents 2009, 301-307.

[64] Drolet, A., Morris, M. 2000. Rapport in conflict resolution: Accounting for how face-to-face contact fosters cooperation in mixed-motive conflicts. Journal of Experimental Social Psychology 36: 26-50.

[65] Lee, V., Wagner, H. 2002. The effect of social presence on the facial and verbal expression of emotion and the interrelationships among emotion components. Journal of Nonverbal Behavior 26(1): 3–25.

[66] Walther, J., D'Addario, K. 2001. The impacts of emoticons on message interpretation in computer-mediated communication. Social Science Computer Rev 19: 324–347.

[67] Hatfield, E., Cacioppo, J., and Rapson, R. 1992. Primitive emotional contagion. In M. S. Clark (ed.), Emotion and social behavior. Review of personality and social psychology 14: 151–177.

[68] Thompson, M., Naccarato, M., Parker, K., and Moskowitz, G. 2001. The personal need for structure and personal fear of invalidity measures: Historical perspectives, current applications, and future directions. In G. B. Moskowitz (ed.), Cognitive social psychology: The Princeton symposium on the legacy and future of social cognition, 19-39, Mahwah, NJ: Lawrence Erlbaum.

[69] Van Kleef, G., De Dreu, C., and Manstead, A. 2006. Supplication and appeasement in negotiation: The interpersonal effects of disappointment, worry, guilt, and regret. Journal of Personality and Social Psychology 91: 124-142.

[70] Overbeck, J., Neale, M., and Govan, C. 2010. I feel, therefore you act: Intrapersonal and interpersonal effects of emotion on negotiation as a function of social power. Organizational Behavior and Human Decision Processes 112: 126-139.

[71] Sheppard, B. 1995. Negotiating in long term mutually interdependent relationships among relative equals. In R. J. Bies, R. J. Lewicki, and B. H. Sheppard (eds.), Research in organizational behavior Vol.5, 3-44, JAI Press.

[72] Bickmore, T., Picard, R. 2005. Establishing and maintaining long-term human–computer relationships. ACM Transactions on Computer–Human Interaction (TOCHI) 12(2): 293–327.

[73] Van Kleef, G., Dreu, D. Longer-term consequences of anger expression in negotiation: Retaliation or spillover? Journal of Experimental Social Psychology 46: 753-760.

[74] Ellsworth, P., Scherer, K. 2003. Appraisal Processes in Emotion. In: Davidson, R.J., Scherer, K.R., Goldsmith, H.H. (eds.) Handbook of Affective Sciences, Oxford University Press, Oxford, 572–595.

[75] Hareli, S., Hess, U. 2009. What emotional reactions can tell us about the nature of others: An appraisal perspective on person perception. Cognition & Emotion 24 (1): 128-140.