Social Visualization and Negotiation: Effects of Feedback Configuration and Status

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ABSTRACT

We describe a social visualization system that monitors the vocal arousal levels of the participants in a simulated two-party employment negotiation. In a 3x2 factorial experiment (N = 84), we manipulate two variables of interest for social visualization systems: the *feedback configuration* of the system's display (participants receive self feedback vs. partner feedback vs. no feedback) and the *status* of the interactants (high vs. low). Receiving feedback about one's own arousal level has negative consequences for performance in and feelings about the negotiation. Receiving feedback about one's partner's arousal level interacts with status: high-status individuals benefit from the visualization, while low-status individuals do not.

Author Keywords

CSCW, social visualization, negotiation, arousal, feedback systems.

ACM Classification Keywords

H.5.3 Group and Organization Interfaces: Computer-supported cooperative work

General Terms

Human Factors; Experimentation; Theory; Design.

INTRODUCTION

A great deal of human communication relies on the exchange of information through non-linguistic channels [19]. For example, posture can convey engagement [25], physical distance can convey intimacy [12], and unstated group dynamics can shape the course of interactions [26]. For both individuals and groups, these hidden social behaviors often surface involuntarily, leading many to view them as authentic ways to convey information [22].

In recent years, a number of studies have looked at the effects of *social visualizations*, which are systems that monitor such implicitly exchanged social information and make it explicit in real-time interactions. Many of these have focused on representing aspects of group dynamics, particularly balance in participation [3, 9, 10, 16, 17], while other efforts have focused on representing attributes of individuals, most commonly arousal [8, 14, 29].

In general, social visualizations have been designed with the intent of supporting or enhancing communication, but their actual effects on interactions have been mixed. Many studies have reported both positive and negative results: DiMicco et al.'s shared display reduced the over-participation of dominant individuals but may have stunted within-group trust [9]; Leshed et al.'s GroupMeter caused more agreement but less discussion of ideas [17]; Wang et al.'s arousal-based animated chat client was seen as engaging, but some participants were reluctant to share their arousal data with their partners [29].

In addition, some studies have reported social visualization effects that were moderated by individuals' characteristics: Kim et al. found that groups with a dominant member reacted differently from those with no dominant member [16], and both DiMicco et al. [10] and Bergstrom and Karahalios [3] reported that over-participators and under-participators responded to visualizations differently.

Against this complex empirical backdrop, it is difficult to infer much about social visualizations in general. This is due, at least in part, to the fact that most studies have taken what Nass and Mason [21] call a *holistic approach*, which considers the effects of a complex intervention as a whole rather than the effects of an intervention's component dimensions. This approach has allows for clear tests when the intervention and situation of interest are well defined. But the approach is of limited utility for making inferences that extend beyond the specific context under study.

To build a more general body of knowledge, a better alternative is to adopt a *variable-centered approach* [21], in which the goal is to understand the effects not of interventions per se, but of dimensions that span technologies and situations. Some researchers have indeed isolated and manipulated such dimensions within their studies; for example, Leshed et al. [17] and DiMicco et al. [10] varied aspects of the feedback display, and Kim et al. [16] manipulated the collocation of participants. However, the literature as a whole has put little emphasis on developing theories around the fundamental dimensions

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underlying social visualizations. A principal focus of the present work is to adopt precisely such a variable-centered approach, with the goal of contributing to a broader and more basic understanding of social visualization systems.

Feedback Configuration

The primary variable of interest in this study is *feedback configuration*. This refers to how the visualization is configured with respect to the constellation of interactants – that is, whose behavior is displayed and to whom the display is shown. This represents one of the fundamental design decisions of any social visualization: the experience of using a social visualization is certain to be radically different if, e.g., one sees feedback about oneself versus about one's partner, or if the system shows the visualization to all people in the interaction versus only to some.

Yet no study to date has addressed this as a variable of theoretical concern. This is somewhat surprising given that prior work has been quite divergent in its treatment of this issue. For example, in Iwasaki et al. [14], interactants only saw their partners' behaviors and were unable to tell how they themselves were perceived; in Janssen, et al. [15], only one person per dyad was monitored, while the other person received feedback about the monitored individual; while in a number of studies [8, 9, 10, 16, 17], all interactants saw representations of each other's actions (a configuration that Erickson has set forth as one of six "claims" for how social visualizations should be designed [11]).

Despite these diverse approaches, we are only aware of one report in which the social-visualization configuration was explicitly manipulated. Wang et al. [29] describe two pilot studies in which a chat client visualized participants' arousal levels. In one study, two partners were shown feedback about each other. In a second study, only one partner was monitored, while the other saw that person's feedback. Unfortunately, this manipulation was confounded by a change in situation (from a conversation between peers to a teacher/student tutorial), and the number of participants (four dyads total) was too small to make broader inferences.

For the present study, we focus on three configurations of a social visualization in a dyadic interaction: feedback about oneself, feedback about one's partner, and no feedback. In all three conditions, both interactants were given the same type of feedback; that is, both interactants saw feedback about themselves, saw feedback about each other, or saw no feedback at all. We kept the configuration symmetric within dyads so as to avoid conferring different status levels on the interactants through differential access to the visualization – a particularly important consideration given that we also manipulated status in the experiment (discussed below).

It is relatively simple to imagine how having feedback about either oneself or one's partner might improve one's experience in an interaction. In both cases, individuals have more information about the emotional content of the interaction, which can aid in managing self-presentation (in the self-feedback case) or in establishing rapport (in the partner-feedback case).

However, it is also possible that either self-feedback or partner-feedback could have negative effects, for at least two possible reasons. First, objective self-awareness theory [7] states that increased self-focus often leads to a state of discomfort as people try but fail to conform to ideal standards. In the self-feedback case, self-awareness may be heightened as people see explicit representations of social signals that they normally convey unconsciously. Prior work suggests that self-awareness might also be increased in the partner-feedback case as well, as stimuli that increase the salience of an audience have been known to activate self-awareness impulses [30].

Second, either self- or partner-feedback may hurt interactions if they increase participants' cognitive loads. While prior social visualization studies [10, 17] have failed to find evidence for this, it is possible that certain feedback configurations make greater cognitive demands than others.

The above considerations led us to pose the following research questions:

RQ1: Does receiving feedback about oneself or one's partner help or hurt one's experience in an interaction, as compared to receiving no feedback?

RQ2: Can either self-awareness or cognitive load explain any observed negative effects of feedback configuration?

It is important to note that even participants in the no-feedback condition knew that a system was monitoring their behaviors. Studies have often compared interactions in which social visualizations were present versus absent. Unfortunately, this approach confounds the presence of the visualization itself with the fact that individuals' behaviors are being monitored. Because the mere presence of an audience can affect behavior [e.g., 31]—a finding that has been extended to human-computer interaction via media-equation theory [24]—it is impossible to know whether differences should be attributed to the representation of one's behaviors in a social setting or to the fact that one is being monitored by a system. Because our concern here is not with being monitored per se but with who sees representations of monitored behaviors, participants were monitored even in the "control" condition, thereby ensuring that the only differences across levels of *feedback configuration* were who had access to the feedback.

Status

The second variable of interest is the *status* of the individuals within the interaction. Status differences play a critical role in many situations in which social visualizations are likely to be deployed. For example, workplace monitoring systems are generally not designed to be egalitarian: lower-level workers are more likely to be monitored by their bosses than the other way around. It therefore seems likely that one's status could influence the

effects of social visualizations. Unfortunately, this topic has been absent from prior social-visualization research.

In this study, we assigned one participant in each dyad to a high-status role and the other to a low-status role. We were not interested in the main effects of status, because that is not a computer-mediation question. Instead, we were interested in possible interactions between status and feedback configuration:

RQ3: Are the effects of self- or partner-feedback moderated by one's status in the interaction?

As a methodological point, we emphasize that we manipulated rather than measured individuals' status levels in the interaction. Previous work on individual-level differences in social visualizations has measured variables via self-report [16] or observer coding [10]. This leads to tenuous inferences because measured variables are likely to correlate with unobserved factors (e.g., dominance may correlate positively with extraversion or negatively with agreeableness). By randomly assigning individuals to high- and low-status roles, we can ensure that any differences are attributable to differences in this variable alone.

Negotiation and Arousal

We situate the present study within the context of a mock employment negotiation scenario. This scenario has a number of properties that make it a useful context for social-visualization research. Employment negotiation is an instance of what McGrath [18] has called "mixed-motive tasks," in which interactants must resolve differing preferences to come to an agreement. This represents a largely unexplored domain for social-visualization research, which has primarily focused either on unstructured conversations [3, 29] or on what McGrath terms "creative," [16, 17] "intellective," [10, 16] or "decision-making" [17] tasks. In addition, as negotiation is a vital activity in a number of contexts, any effects of social visualizations on negotiation outcomes should be of broad interest even outside the CSCW and HCI communities.

Social cues play an important role in predicting negotiation outcomes, making explicit feedback about these cues a potentially useful intervention. In particular, Curhan and Pentland [6] demonstrated that arousal (or "emphasis") is negatively correlated with negotiation outcomes: people who speak with higher arousal tend to perform worse in negotiations. No other social signal in their study was significantly predictive of negotiation outcomes for both high- and low-status actors, suggesting that arousal plays a particularly salient role in the negotiation context.

Negotiation scenarios involve both objective outcomes, which indicate the amount of economic value gained or lost, and subjective outcomes, which describe one's perceptions about the nature of the interaction [5]. In the present scenario, objective performance is determined by allocating points in accordance with each individual's performance in the negotiation. Subjective experience is evaluated using multiple metrics: individuals' own overall perceived experience quality, the degree to which they felt their dyads were competitive or cooperative, and their perceptions of their partners.

METHODS AND SYSTEM DESCRIPTION

Eighty-four participants (48 female; mean age 21.5) were recruited via campus mailing lists and course announcements. Participants came to an on-campus lab and were told that they would be participating in a simulated employment negotiation between a middle manager and a vice president (roles randomly assigned within dyad). The study lasted approximately 1.5 hours. Participants were offered either course credit or $30 in exchange for participating. As an incentive for thoughtful participation, one pair was randomly selected to receive a cash prize, distributed in accordance with their performance in the negotiation. All experimental sessions were conducted using same-gender pairs in order to avoid known issues of gender differences in negotiation outcomes [27].

Computer Monitoring of Arousal

Before the start of the negotiation, participants were shown a web page that explained that previous research had shown that people who spoke in an excited fashion in negotiations tended to have worse outcomes than people who spoke in a calm manner [6]. All participants were told that their voices would be monitored during the negotiation by a computer that was designed to detect differences in excitement as manifested through vocal cues.

Participants in the self-feedback condition were also told:

> As you talk, you will see feedback about the excitement level of your voice. Meanwhile, your partner will similarly see feedback about the excitement level of his/her own voice.

Similarly, participants in the partner-feedback condition were told:

> As you talk, you will see feedback about the excitement level of your partner's voice. Meanwhile, your partner will similarly see feedback about the excitement level of your voice.

Participants in both the self-feedback and partner-feedback conditions were shown a screenshot of the VoiceScan application (Figure 1). Participants in the no-feedback condition were not told about the VoiceScan visualization nor shown a screenshot.

Negotiation Scenario

Next, participants were given 15 minutes to review the instructions outlining the negotiation scenario. In the scenario, which has been used in various negotiation studies and classroom settings [6, 23], the middle manager has requested a transfer to a new branch of a multinational corporation overseen by the vice president. The two must come to an agreement on an employment package consisting of eight issues, such as salary, health insurance, and vacation days. Each issue has five possible outcomes,

with corresponding positive or negative point values. Participants were told that the vice president had the final say on whether or not to approve the transfer; however, it was emphasized that it was in both participants' best interests to come to an agreement if they could find one such that both earned any number of points above zero.

The eight issues in the scenario reflect three different issue types [23]. *Distributive* issues are ones in which the two participants' values are diametrically opposed: every point that the vice president earns is a point that the middle manager loses, and vice versa. *Compatible* issues are ones in which the parties' values are perfectly aligned: every point that the vice president earns is a point that the middle manager also earns. *Integrative* issues are ones in which the parties have opposite but unequal incentives: one issue is worth more to the vice president while another is worth more to the middle manager. Integrative issues require cooperation and synthesis for both parties to receive high scores. Thus, it was possible for both parties to score relatively low or both to score relatively high, regardless of who "won" the negotiation. If both parties earned high scores, it indicated that they were communicating effectively and balancing competition with cooperation.

Calibration Phase

After reviewing the negotiation instructions, each participant went through a "calibration phase" to establish baseline calm and excited states so that the system could accurately analyze his or her voice. During this phase, the participant made two calls using provided PSTN telephones to an Asterisk telephony server [28], which bridged each call to a voicemail repository. During the first call, the participant was instructed to speak as calmly and steadily as possible; during the second call, he or she was told to speak as excitedly and dynamically as possible. For each call, a short passage was provided for the participant to read aloud. To make the task of performing calm and excited states easier for the participants, a descriptive passage with long, florid sentences was chosen for the calm call, while an action-filled passage with short, choppy sentences was chosen for the excited call.

For each call, a Java module connected to Asterisk via the Asterisk Gateway Interface extracted the first 30 seconds of the call and saved the recording as a .wav file on the server. This .wav file was then processed by Praat [4], a speech-analysis software package, which extracted the pitch median and interquartile range from the 30-second recording. Thus, after the two calls in the calibration phase were complete, the system had four readings for each participant: his or her pitch median and range in a calm state, and his or her pitch median and range in an excited state. These values were then associated with the participant's unique ID and stored in a MySQL database.

Live Phase

After both participants completed the calibration phase, they were instructed to begin the negotiation itself. The vice president dialed a new phone number that again activated the Asterisk telephony server, though this call was bridged to the middle manager's phone. Thus, the two participants were able to talk directly over standard landlines while the system monitored their speech signals in real time.

Speech signals from each participant were processed through different channels by the telephony server. During the negotiation, the Java module extracted speech signals for each participant at seven-second intervals and saved them as .wav files on the server. The pitch median and pitch range of each seven-second chunk of speech was then extracted by Praat. Arousal scores were calculated for each feature as follows:

$$A_{median} = (M_{live} - M_{calm}) / (M_{exc} - M_{calm})$$

$$A_{range} = (R_{live} - R_{calm}) / (R_{exc} - R_{calm})$$

where A_{median} is the score for pitch median, A_{range} is the score for pitch range, M represents the pitch median, R represents the pitch range, *live* denotes values in the live negotiation, *calm* denotes calm calibration values, and *exc* denotes excited calibration values. To protect against outliers, the maximum *live* value for each feature was limited to 25% above the corresponding excited calibration value and the minimum was limited to 25% below the calm calibration value. Scores for each feature were summed to compute a composite arousal score, which was scaled to fall between a minimum of 0 and a maximum of 4.

The validity of this approach was demonstrated during a pilot phase in which participants were shown a real-time feedback graph with data generated via the parameters above. All pilot participants reported being able to manipulate the graph easily by alternating between calmer and more excited speaking states.

During the negotiation (mean length = 13.6 minutes), participants were shown a webpage with a series of form fields for each issue. For each issue, participants checked a radio button next to the agreed-upon level; at the conclusion of the negotiation, they entered their selections via a form submission button. Next to the form fields, participants in the self-feedback and partner-feedback conditions were also shown a Flash visualization labeled "VoiceScan" that

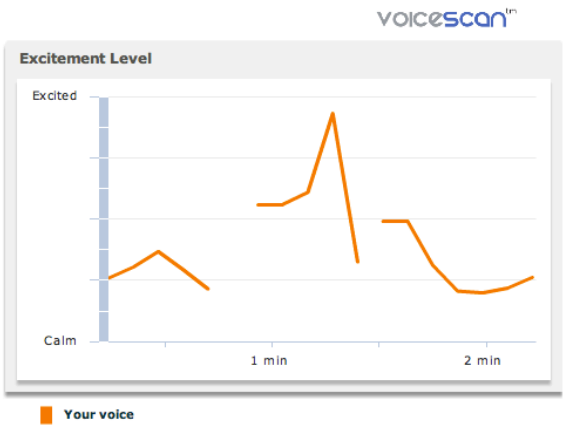

Figure 1: VoiceScan screenshot, self-feedback condition

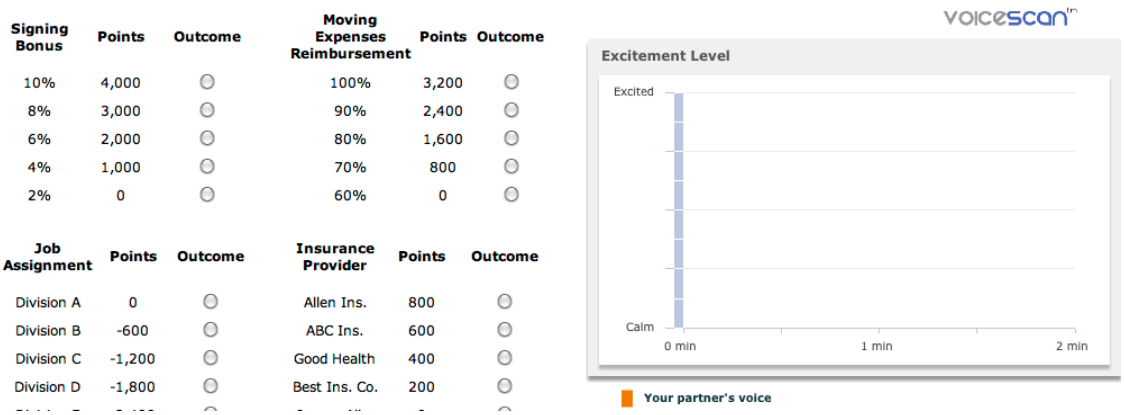

Figure 2: Negotiation interface (partial view); partner-feedback / middle-manager perspective.

displayed an animated line chart showing time on the x-axis and arousal on the y-axis. The graph was captioned "your voice" in the self-feedback condition and "your partner's voice" in the partner-feedback condition (Figure 2). In the no-feedback condition, no graph was shown.

Post-Questionnaire and Debrief

After completing the negotiation, participants filled out a post-questionnaire and were then debriefed, compensated, and dismissed.

Measures

Negotiation points. Because the scenario involves both integrative and distributive issues, negotiation points can be considered in two ways. The total points created by the dyad indicate the total amount of "value creation," or how well the counterparts worked together. The points earned by each individual within a dyad reflect "value claiming" – that is, how effective the individual was at winning points for him- or herself [6].

Subjective Value Inventory. This 16-item scale measures the subjective value that each participant felt that he or she gained from the interaction [5]. The concept of *subjective value* includes the fairness of the process, the perceived quality of the working relationship, and the impact of the negotiation on one's self-image. Subjective value is a critical component of the negotiation process, particularly in cases, such as employment, in which the two counterparts have to work together after the negotiation. The scale was very reliable (Cronbach's $\alpha = 0.93$).

Cooperativeness. This scale was comprised of three items, each measured on 10-point Likert scales: *How well did you and the other person work together?* ("Not well at all" (=1) to "Very well" (=10)), *How much did the other person cooperate with you?* ("Not at all" (=1) to "A lot" (=10)), and *How much did you cooperate with the other person?* ("Not at all" (=1) to "A lot" (=10)). The scale was very reliable ($\alpha = 0.81$).

Competitiveness. Two questions, both measured on 10-point Likert scales, gauged the competitiveness of the parties in the interaction: *How competitive was the other person?* and *How competitive were you?* ("Not at all competitive" (=1) and "Extremely competitive" (=10)). Because these questions were uncorrelated ($\rho = 0.11$), we include each as a single item in our analysis.

Perspective taking. Two statements gauged the degree of perspective-taking in the interaction: *I worked hard to think about things from my partner's perspective* and *My partner worked hard to think about things from my perspective*. Each statement was accompanied by a 7-point Likert scale with labels ranging from "Strongly disagree" (=1) to "Strongly agree" (=7). Because these questions were not highly correlated ($\rho = 0.57$), we include each as a single item in our analysis.

Partner friendliness. Participants rated how well *friendly*, *likable*, and *easy to talk to* described their partners, using 10-point Likert scales ("Describes very poorly" (=1) and "Describes very well" (=10)). The scale was very reliable ($\alpha = 0.88$).

Self-consciousness. Participants rated how well *self-conscious* described themselves, using a 10-point Likert scale ("Describes very poorly" (=1) and "Describes very well" (=10)).

Task Load Index. Five questions from the NASA Task Load Index [13] measured cognitive load. One item from the standard index measuring physical demand was omitted because it was irrelevant to this task. The scale was only somewhat reliable ($\alpha = 0.66$), but we include it here because it has been extensively validated.

RESULTS

Three dyads were removed from the data set prior to analysis;[1] thus, all analyses were conducted on a data set of

[1] In one case, this was due to a technical problem with the system calibration; in another, experimental protocols were not followed properly by the researcher; in the third, the two participants realized that they knew each other partway through the phone call and mentioned in the debrief that this affected their negotiation.

78 total participants. For *feedback configuration*, there were 24 participants in the self-feedback condition, 28 in the partner-feedback condition, and 26 in the no-feedback condition. *Status* was a within-dyad variable, so both levels of status were equally represented within each level of *feedback configuration*.

The focus of this study is on how receiving no feedback differs from receiving feedback either about oneself or about one's partner. This would normally call for analyses using Dunnett's *t*, which is commonly used when multiple treatments are compared to a single control. However, because we are also interested in potential interactions between *feedback configuration* and *status*, Dunnett's *t* is not appropriate. Instead, we simply compare the no-feedback condition to the self-feedback and partner-feedback conditions in turn, and apply a conservative Bonferroni correction: we use a critical α value of 0.025 (two-tailed) instead of the standard 0.05. All post-hoc tests on interaction effects were performed using Tukey's HSD.

As the main effect of *status* was not of theoretical interest in this study, we do not included detailed statistics in the results below. We did include this factor in our models; there were no significant main effects of *status* for any outcome measures.

Analyses were conducted by fitting multilevel models [2] using *feedback configuration* and *status* as fixed effects and *dyad* as a random effect. We also included *gender* as a random effect to reduce the variance associated with gender differences in negotiation outcomes [27]. Because the calculation of degrees of freedom for *t* statistics in such models is known to be problematic, *p*-values were generated via Markov-Chain Monte Carlo sampling [1].

Negotiation points. For self feedback vs. no feedback, there was a marginally significant main effect of *feedback configuration*, $t = 2.27$, $p < 0.03$, resulting from a marginally significant interaction between *feedback configuration* and *status*, $t = 2.05$, $p < 0.05$. In the no-feedback condition, middle managers scored higher than vice presidents, $p < 0.02$; in the self-feedback condition, there was no difference, $p > 0.9$.

For partner feedback vs. no feedback, there was no significant effect of *feedback configuration*, $t = 0.82$, $p > 0.4$. There was a significant crossover interaction between *feedback configuration* and *status*, $t = 3.94$, $p < 0.001$. In the no-feedback condition, middle managers scored more points than vice presidents, $p < 0.02$; in the partner-feedback condition, vice presidents scored more points than middle managers, $p < 0.06$ (Figure 4).

Subjective value. For self feedback vs. no feedback, there was a significant main effect of *feedback configuration*, $t = 3.14$, $p < 0.01$. Participants in the self-feedback condition felt less subjective value than those in the no-feedback condition. There was no significant interaction between *feedback configuration* and *status*, $t = 1.39$, $p > 0.1$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.40$, $p > 0.6$. There was a significant interaction between *feedback configuration* and *status*, $t = 2.67$, $p < 0.02$. Vice presidents felt greater subjective value in the partner-feedback condition than in the no-feedback condition, $p < 0.10$, but for middle managers there was no difference between conditions, $p > 0.4$ (Figure 5).

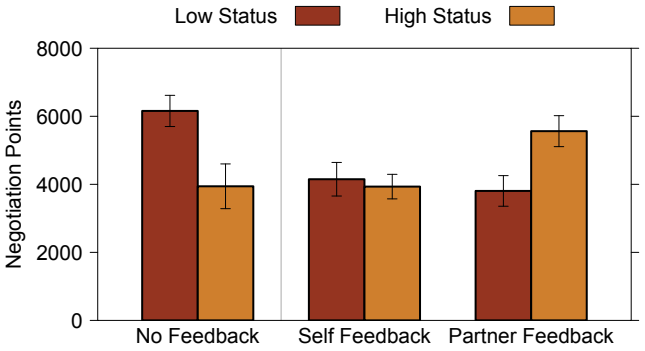

Figure 4: Negotiation points. Means = {6,158, 3,942, 4,150, 3,933, 3,806, 5,563}; SEs = {458, 658, 494, 361, 450, 455}

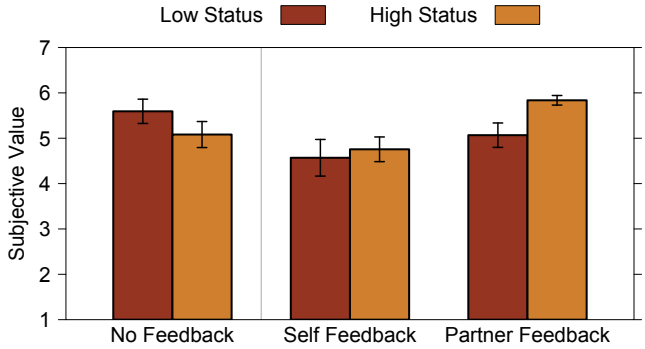

Figure 5: Subjective value. Means = {5.59, 5.08, 4.57, 4.76, 5.07, 5.84}; SEs = {0.27, 0.29, 0.40, 0.27, 0.27, 0.11}

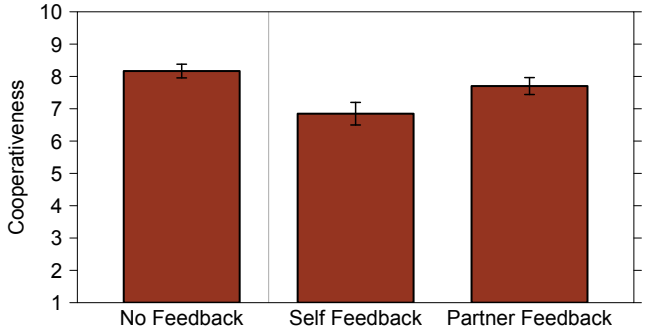

Figure 6: Cooperativeness. Means = {8.17, 6.85, 7.70}; SEs = {0.21, 0.35, 0.26}

Cooperativeness. For self feedback vs. no feedback, there was a significant main effect of *feedback configuration*, $t = 3.43$, $p < 0.02$. Participants in the self-feedback condition felt that their interactions were less cooperative than those in the no-feedback condition. There was no significant interaction between *feedback configuration* and *status*, $t = 0.92$, $p > 0.3$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 1.22$, $p > 0.2$, and no significant interaction between *feedback configuration* and *status*, $t = 1.50$, $p > 0.1$ (Figure 6).

Partner competitiveness. For self feedback vs. no feedback, there was a significant main effect of *feedback configuration*, $t = 2.34$, $p < 0.025$. Participants in the self-feedback condition felt that their partners were more competitive than those in the no-feedback condition. There was no significant interaction between *feedback configuration* and *status*, $t = 1.56$, $p > 0.1$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.06$, $p > 0.9$, and no significant interaction between *feedback configuration* and *status*, $t = 0.98$, $p > 0.3$ (Figure 7).

Self competitiveness. For self feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 1.49$, $p > 0.1$, and no significant interaction between *feedback configuration* and *status*, $t = 0.77$, $p > 0.4$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 1.11$, $p > 0.2$. There was a significant interaction between *feedback configuration* and *status*, $t = 2.37$, $p < 0.025$. Vice presidents felt more competitive in the partner-feedback condition than in the no-feedback condition, $p < 0.09$; there was no difference for middle managers, $p > 0.9$ (Figure 8).

Partner perspective taking. For self feedback vs. no feedback, there was a significant main effect of *feedback configuration*, $t = 2.53$, $p < 0.02$. Participants in the self-feedback condition felt that their partners did not try as hard to think about things from their perspectives as did those in the no-feedback condition. There was no significant interaction between *feedback configuration* and *status*, $t = 0.18$, $p > 0.8$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.50$, $p > 0.6$, and no significant interaction between *feedback configuration* and *status*, $t = 1.09$, $p > 0.2$ (Figure 9).

Self perspective taking. For self feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.34$, $p > 0.7$, and no significant interaction between *feedback configuration* and *status*, $t = 1.43$, $p > 0.1$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.83$, $p > 0.4$, and no significant interaction between *feedback configuration* and *status*, $t = 0.34$, $p > 0.7$.

Partner friendliness. For self feedback vs. no feedback, there was a significant main effect of *feedback configuration*, $t = 2.53$, $p < 0.02$. Participants in the self-feedback condition felt that their partners were less friendly than those in the no-feedback condition. There was no significant interaction between *feedback configuration* and *status*, $t = 0.45$, $p > 0.6$.

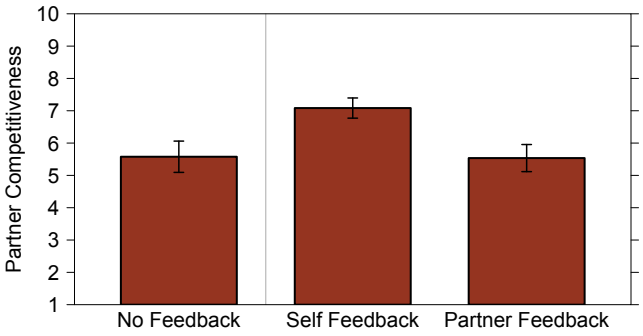

Figure 7: Partner competitiveness. Means = {5.58, 7.08, 5.54}; SEs = {0.48, 0.31, 0.42}

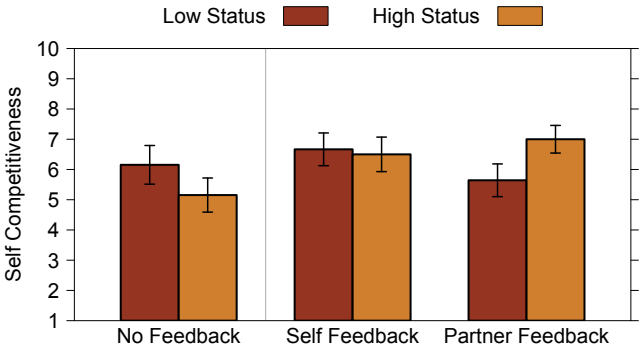

Figure 8: Self competitiveness. Means = {6.15, 5.15, 6.67, 6.50, 5.64, 7.00}; SEs = {0.64, 0.56, 0.54, 0.57, 0.54, 0.46}

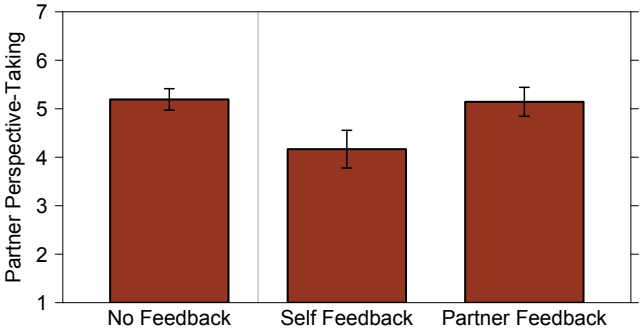

Figure 9: Partner perspective taking. Means = {5.19, 4.17, 5.14}; SEs = {0.22, 0.39, 0.30}

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.70$, $p > 0.4$, and no significant interaction between *feedback configuration* and *status*, $t = 1.40$, $p > 0.1$ (Figure 10).

Self-consciousness. For self feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.16$, $p > 0.8$. There was a significant crossover interaction between *feedback configuration* and *status*, $t = 3.78$, $p < 0.001$. Middle managers were more self-conscious in the self-feedback condition than in the no-feedback condition, $p < 0.06$; vice presidents were less self-conscious, $p < 0.03$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.66$, $p > 0.5$. There was a significant interaction between *feedback configuration* and *status*, $t = 2.69$, $p < 0.01$. In the no-feedback condition, vice presidents were more self-conscious than middle managers, $p < 0.01$; in the partner-feedback condition, there was no difference, $p > 0.9$ (Figure 11).

Task load. For self feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.68$, $p > 0.5$, and no significant interaction between *feedback configuration* and *status*, $t = 1.45$, $p > 0.1$.

For partner feedback vs. no feedback, there was no significant main effect of *feedback configuration*, $t = 0.07$, $p > 0.9$, and no significant interaction between *feedback configuration* and *status*, $t = 0.80$, $p > 0.4$.

DISCUSSION

Self Feedback

With respect to RQ1, we find that receiving feedback about one's own arousal level had negative effects on many aspects of the negotiations. When participants received feedback about themselves, they felt subjectively worse about the negotiations, found their interactions to be less cooperative, and found their partners to be more competitive, less friendly, and less willing to see things from their perspectives.

For RQ3, we find evidence that *status* may have moderated the effects of *feedback configuration* for objective performance: low-status individuals claimed less value when self-feedback was present, while high-status individuals claimed the same amount of value (though this effect was only marginally significant). Interestingly, however, we find no interactions in terms of people's subjective perceptions of the negotiation: self-feedback hurt low- and high-status people alike.

Addressing RQ2, we find no evidence that these negative effects were caused by additional cognitive load. Meanwhile, we find mixed support for the possibility that the negative effects are due to heightened self-awareness. Low-status individuals indeed reported feeling more self-conscious when self-feedback was shown than when no feedback was shown; however, the opposite trend was true for high-status individuals.

One possible explanation for these results is that heightened self-awareness did indeed interfere with the interactions for all participants, but the single *self-consciousness* item was too simplistic a measure to provide a reliable indicator of this. It is possible that participants construed "self-consciousness" in its colloquial sense as referring to anxiety about the self, rather than as referring to a broader notion of awareness the self. In this case, all individuals may have felt heightened self-awareness in the presence of self-feedback, but this may have only implicated related anxiety for low-status individuals.

If self-awareness but not anxiety is responsible for the negative effects of self-feedback, it is possible that rapport was stunted simply because people focused more on how they were being perceived and less on the social cues that their partners were giving off. Additional work should examine the role of objective self-awareness in explaining social-visualization effects in more depth.

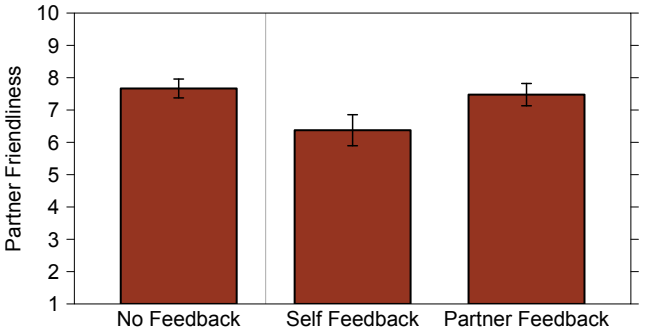

Figure 10: Partner friendliness. Means = {7.67, 6.38, 7.48}; SEs = {0.29, 0.48, 0.34}

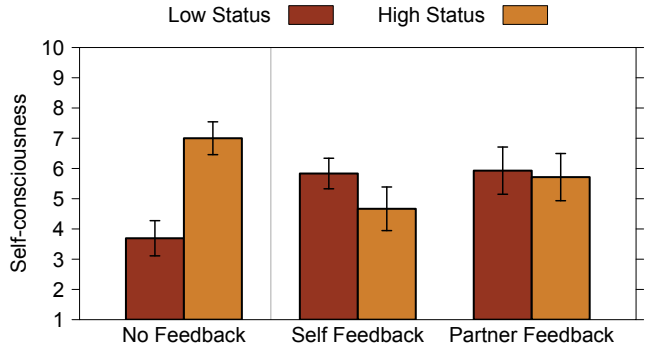

Figure 11: Self-consciousness. Means = {3.69, 7.00, 5.83, 4.67, 5.93, 5.71}; SEs = {0.58, 0.54, 0.51, 0.72, 0.78, 0.78}

Partner feedback

In contrast to the effects of self-feedback, the effects of receiving feedback about one's partner's arousal level were strongly influenced by one's status in the interaction. The higher-status vice presidents clearly benefitted from receiving feedback about their partners, as it caused them to score more points and feel greater subjective value. Interestingly, it also caused them to feel more competitive. Conversely, the effects of partner-feedback on lower-status middle managers were less apparent. Middle managers did claim less value in the partner-feedback condition than in the no-feedback condition, but there was no discernible difference in their subjective experiences. Thus, we find evidence that partner-feedback affects people's interactions (RQ1) but that the effects differ significantly depending on one's status (RQ3).

With respect to RQ2, we once again find no evidence that cognitive load had any bearing on the observed effects. Taken together with the results for self-feedback, as well as similar null results reported in previous work [10, 17], this suggests that people are actually quite capable of incorporating peripheral social visualizations without overloading their cognitive resources.

As with self-feedback, we find mixed support for the notion that heightened self-awareness, as measured by the *self-consciousness* item, can explain the observed results. We do note that in the partner-feedback case, lower-status individuals both created less value and were more self-conscious than in the no-feedback case; however, as per the discussion above, we treat these results as suggestive rather than conclusive.

One interpretation for the positive effect of partner-feedback on high-status individuals is that this subject population—primarily consisting of undergraduate students with little work experience—had inherent difficulty adopting the more powerful role of the vice president. However, receiving feedback about one's partner's voice may have been empowering for the vice president role in a way that it was not for the middle manager role, because in real life monitoring another individual is almost exclusively the purview of higher-status individuals. In other words, monitoring other people may actually be more helpful to high-status individuals (who are presumably in a position to act on that information) than to low-status individuals (who are presumably not in such a position). Particularly given these real-world issues, status is an important topic for future work on social visualizations to explore.

CONCLUSION

This work has several limitations. The present experiment examines the visualization of only one type of social behavior (vocal arousal), in one interactional context (negotiation), between same-gender pairs, in a single setting. It is possible that other social cues may be more appropriate for feedback in negotiations, or that people may benefit from receiving feedback about their own arousal levels in a different situation. It also seems reasonable to conjecture that feedback about one's social cues may be more effectively provided as part of a long-term training regimen rather than in a single laboratory session. All of these would be fruitful areas for future work.

In addition, as with much work in social science, this study makes use of certain contrivances that, while useful for research purposes, should be taken into account when making general inferences based on the findings. Notably, the experiment involves a simulated negotiation and restricts dyads to same-gender pairs. Real-world negotiations are certain to have higher stakes for the parties involved and to often take place between opposite-gender dyads. Examining the issues raised here in more naturalistic scenarios would be a useful extension of this work.

While we are aware of the limitations of the present work, we hope that it provides at least the beginnings of a foundation, grounded in dimensions rather than holistic interventions [21], on which others interested in psychological effects of social visualization systems can build. At a minimum, we hope that this work encourages others to manipulate those specific aspects of system, role, and situation that are likely to help construct a larger theory of social visualization systems.

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