Negative Feedback In Your Face: Examining the Effects of Proxemics and Gender on Learning

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Abstract. While applications of virtual agents in training and pedagogy have largely concentrated on positive valenced environments and interactions, human-human interactions certainly also involve a fair share of negativity that is worth exploring in virtual environments. Further, in natural human interaction as well as in virtual spaces, physical actions arguably account for a great deal of variance in our representations of social concepts (e.g., emotions, attitudes). Proxemics, specifically, is a physical cue that can elicit varying perceptions of a social interaction. In the current paper, we explore the combined and individual effects of proxemic distance and gender in a specifically negative feedback educational context. We pursue this with a 2 (Proxemic Distance) $\times$ 2 (Virtual Instructor Gender) between subject design, where participants actively engage in a learning task with a virtual instructor that provides harsh, negative feedback. While this study demonstrates some anticipated negative reactions to negative feedback from a close distance, such as external attribution of failure, we also observe some unexpected positive outcomes to this negative feedback. Specifically, negative feedback from a close distance has raises positive affect and effort, particularly among male participants interacting with a male virtual professor. Objective measures (head movement data) corroborate these same-gender effects as participants demonstrate more engagement when interacting with a virtual professor of their same gender. The results of the present study have broad implications for the design of intelligent virtual agents for pedagogy and mental health outcomes.

Keywords: Virtual Instructor, Attribution Theory, Proxemics, Affect

1 Introduction

Applications of intelligent virtual agents (VA) to facilitate learning has been well-documented [1–4]. While some research focuses on the agent's appearance [5, 4], others focus on the nature of the agent's communication [6]. That being said, current research on pedagogical agents focuses mainly on the interactions with a positive valence, such as politeness [7] and rapport [8, 9]. A fundamental determinant to how people respond to feedback from virtual agents is the manner in which the feedback is delivered. Research on politeness within [7] and outside [10] the virtual agent research community demonstrate that forms of communication, namely phrasing, are critical. Prior research has shown that both positive phrases [7] and non-verbal behaviors [9] may positively impact the learning outcome.

Real world learning experiences, however, are not necessarily exclusively positive in valence. The effect of negative feedback in educational contexts have long been debated [11]. Kluger and Neulsin [12] argue that negative feedback benefits learning. However, few studies have explored the consequences of a negatively valenced educational context by examining students' reactions and response to a virtual teacher's negative feedback. An exception is the work introduced by Feng et al. (2017) which focuses on explicitly harsh negative feedback, and is discussed further in the related work.

We used a 2×2 design (Gender $\times$ Approach) in a virtual environment, where a male or female virtual agent (depending on condition) provides an identical series of explicitly harsh negative feedback messages while standing either close or far away from the participant. In manipulating who delivered the negative feedback (i.e., a man or a woman) and how (i.e., with what accompanying proxemics), our research goal for this study was to identify differential patterns participants' attributions and affect. We report a number of findings, with the most compelling of which is an unexpected "bounce-back effect" as male participants curiously report positive affect and effort in response to the harsh feedback.

The paper is organized as follows: In Section 2, we present the theoretical background and related work. Our methods and results will be discussed in section 3 and 4. We conclude and discuss the implications and future directions of this work in Section 5 and 6.

2 Related Work

Negative Feedback. First introduced by Dweck [11], the effects of negative feedback in educational contexts have long been a topic of discussion in the field of education and psychology. Some argue that negative feedback benefits learning [12] while others argue that it leads to a learned helplessness that hampers learning [13]. At a fundamental level, negative feedback has been shown to lower motivation [14]. That said, students may employ strategies to address the negative feedback, such as increasing effort [15] and lowering goals and expectations [12]. Such goal regulation strategies have been observed both for legitimate and manipulated feedback [16].

Attribution. A crucial response to negative feedback in an educational context is one's attribution of blame or responsibility. That is, does the student attribute blame to their own poor abilities or do they attribute blame to the instructor's poor teaching abilities? Attribution theory has long been discussed in the field of education [17]. While students' success is often attributed to the self, failures are typically attributed to others [18]. In fact, students tend to ignore negative feedback that contrasts with their own assessments of their performance [19]. What remains to be seen, however, is an understanding of how negative feedback transforms and shifts students attribution tendencies based on the gender of a teacher and the interpersonal distance between the student and the teacher.

Proxemics. Proxemics, or interpersonal distance between communicators, highly impacts the perception of meaning in all forms of human social interaction. Hall (1966) [20] identified 4 types of interpersonal distance zones with varying distances and social meaning: the intimate zone ($0 - 45$ cm), the personal-casual zone (45 - 120 cm), the socio-consultive zone ($120 - 360$ cm), and the public zone ($360 - 750$ cm). Management of and responses to interpersonal distance has also been examined closely among virtual agents [21–24] and robotics [25]. As Bailenson et al. (2001) note, studies about proxemics have historically been wrought with issues of reliability and validity across participants [21]. Virtual environments offer an opportunity to reliably test precisely defined proxemics while also maximizing realism [26].

2.1 Embodied Agents

Research examining learning within virtual environments have mostly made use of computer-driven embodied agents [21]. To have optimal learning effects using virtual agents, studies have underscored the need to integrate socio-emotional and relational variables such as embodiment and nonverbal behavior [27]. These studies have traditionally focused on the effects of positive feedback from virtual agents in a virtual learning environment [27, 9, 8]. For instance, Wang et al. (2008) found that an agent who uses polite requests had a more positive impact on learning than a more direct agent. Further, Krämer et al. (2016) found a significant improvement on participant's performance when interacting with same-gender virtual agents that rapidly respond to the participants with positive non-verbal behavior.

Departing from these prior work, Feng et al. (2017) focused on students' direct response to purely negative feedback from virtual instructors, and found that students attribute greater self-blame (internal attribution) for their purported poor performance when interacting with the female virtual instructor than when interacting with the male virtual instructor [28]. This was accomplished by comparing students' reactions to negative feedback delivered by a virtual agent that stood still with a virtual agent that approached the student in a somewhat threatening manner. While prominent gender differences were found, a potential limitation of the proxemic stimuli was that the approaching behavior happened at the very end of the experiment, which may have softened its threatening intent, which in turn may have muted the experimental manipulation. In order to account for this potential conflation of experimental conditions, the present study examined the differences in perception of a virtual agent standing still at a near and far distance.

2.2 Hypotheses

Generally, this study explores the role of instructor gender, and potential interaction effects of instructor gender with both instructor proxemic distance and student gender (participant) as they impact participant attribution, affect, judgments of the instructor, and head movements. We anticipate the proxemic distance of the virtual instructor to have a wide impact on participants' experiences in this virtual learning environment. Research on Attribution Theory has noted that in general, men tend to attribute success to internal/stable causes while women tend to attribute failures to internal/stable causes. As such, we hypothesize similar gender differences to emerge in the current study [29–31]. This study will further examine these gender effects in a negative feedback-based virtual learning environment, but we have no literature-backed predictions for how gender may potentially interact with proxemics in this negative feedback interaction. We do however, predict that the close distance in the negative feedback context will exacerbate feelings of Dweck's [13] "learned helplessness" , which may be associated with perceptions of less personal control and greater external control. In terms of affect, close interpersonal distance is generally associated with greater intimacy [20], but closer interpersonal distance in a negatively valenced context lead us to expect greater negative affect, lower attributional control, and external attributional tendencies. In line with Edney et al 1976 [32], we also predict that this unwanted closer interpersonal distance would lead to greater reactive head movements (HMD) in order to re-establish personal space.

3 Method

3.1 Participants

117 students from two universities (54 men and 63 women), with an average age of 20.94 (SD = 2.77) participated in this study and were randomly assigned to one of 4 conditions in a 2 (Virtual Instructor Gender) × 2 (Close/Far) between-subjects design. Although assignment to conditions was randomized, the distribution of participants across the 4 conditions was slightly uneven. The number of participants in each condition is shown in Table 1

Table 1. Number of participants in each condition

Proxemics	Virtual Instructor Gender	Male Participants	Female Participants
Close	Male	14	14
	Female	13	11
Far	Male	10	19
	Female	17	19

3.2 Measures

To examine the changes of the participants' affect and attribution, we used the same measures introduced in [28], including Positive and Negative Affect Schedule-Expanded Form (PANAS-X), The Revised Causal Dimension Scale II (CDSII) and additional Ad-Hoc Questions about participants' judgments of the experiment.

Another significant factor in the present study was the degree to which participants truly believed that the negative feedback they were receiving was tailored and specific to each person. Although efforts were made to make the virtual environment authentic, some participants could pick up on the actual non-intelligent nature of the virtual environment. As such, a manipulation check was delivered to the participants in the form of two items on a 7-point Likert scale (anchors extremely inauthentic and extremely authentic): "To what extent did you feel that the instructor's feedback was authentic/real?" and "To what extent did you feel that the virtual environment was authentic/real?"

Head Movement Head movement data coordinates for x-, y-, and z-axes were recorded at 25 separate time points over the course of the actual acting experiment. Each time point interval varied as the time points were event-based. That is time points were tagged according to the statements made by Virtual Instructor throughout the experiment. Naturally, the time points were identical across all participants. Head movement were analyzed for aggregate movement (bi-directional) and directional movement (uni-directional).

Aggregate Head Movement (Bi-Directional) was calculated by summing up the absolute values of the differences between each pair of the sequential data points, as shown in Equation (1). In other words, the absolute value of the difference between time 1 and time 2 was added with the absolute value of the difference between time 2 and time 3, and so on up to the absolute value of the difference between time 24 and time 25. By summing up the absolute values of each time point for each axis, we computed aggregate movement variables for each axis. The formulas for the movement variables of each axis are depicted below.

$$\begin{aligned} Aggregate\ movement = |i_1 - i_2| + ... + |i_n - i_{n+1}| + .. + |i_{24} - i_{25}|), \\ i \in \{x - axis, y - axis, z - axis\}, \end{aligned} \tag{1}$$

Directional Head Movement(Uni-Directional) was calculated by summing the non-absolute differences between each pair of sequential data points. The output generated by this formula represents the aggregate movement direction that the participants tended to move towards over the course of the experiment for each x-,y-, and z- axes. The formulas for the movement direction variables are depicted in Equation (2).

$$\begin{aligned} Directional\ movement = (i_1 - i_2) + ... + (i_n - i_{n+1}) + .. + (i_{24} - i_{25}), \\ i \in \{x - axis, y - axis, z - axis\}, \end{aligned} \tag{2}$$

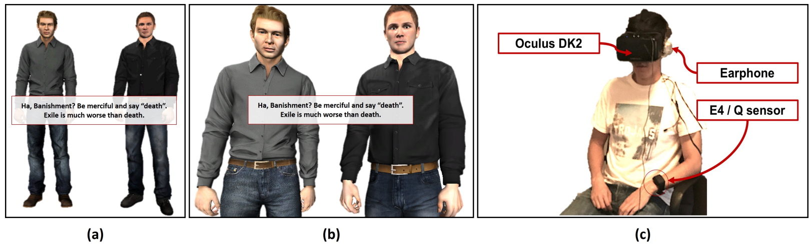

Fig. 1. Screen-shot of the virtual environment in far condition (a) and close condition(b). In far condition(a), the virtual instructor stands far away from the participants at the beginning of the experiment while in closing condition (b), the virtual instructor stands right in front of the participants' face. (c) shows the system apparatus.

3.3 Materials

We created a contextualized virtual environment that aims at invoking the key components of negative feedback, namely, the feeling of helplessness and lack of motivation. Specifically, we simulated an acting rehearsal in an acting class scenario. Participants took the role of an acting student, reading lines from 'Romeo and Juliet' while taking instruction from a virtual instructor. Participants were told that the instructor's feedback was specifically tailored to their performance, but the twist here was that the negative feedback from the virtual instructor was scripted and identical for all participants regardless of their performance. Each time the participant finished reading a line, the virtual instructor provided negative feedback using harsh language along with negative non-verbals. For example,"You sound like a dead fish" and "No no no, that's not right". Participant engaged in the acting rehearsal with a second virtual agent, which took on the role of a fellow acting student (See Fig. 1). In other words, the Instructor virtual agent provided the negative feedback and the Student virtual agent engaged in a rehearsed conversational exchange with the research participant(s). The virtual instructor, however, never provided any feedback to or even directed eye gaze at the virtual student.

3.4 Experiment Procedure

Prior to arrival, participants were randomly assigned to one of four conditions (Male Close, Female Close, Male Far, Female Far). As they began to read the informed consent form, participants were fitted with the E4/Q skin conductance measure bracelet. After completing this briefing session, participants were asked to fill out the PANAS-X (pre-test) and the Rosenberg Self-Esteem Scale. After completing those two questionnaires, participants were fitted with the HMD and headphones at an appropriate distance of about 5 feet from the HMD sensor. Upon completing the experiment, the participants responded to additional questionnaire measurements including the PANAS-X (post-test) and the CDS II. Each session for a given participant lasted no more than 30 minutes.

4 Result

4.1 Data Preparation

CDS II Factor analysis was conducted on individual subscales that make up the Causal Dimension Scale II. Five items under the Locus of causality dimension of the CDSII were examined via principal components analysis using varimax rotation. All five items loaded onto one factor and were retained under a locus of causality composite measure (Cronbachs $\alpha = .86$). Three items under the personal dimension of the CDSII were examined via principal components analysis and were all found to load on one factor (Cronbachs $\alpha = .87$). Three items under the stability dimension of the CDSII were examined via principal components analysis using varimax rotation, and all loaded on one factor (Cronbachs $\alpha = .73$). Six items under the external dimension of the CDSII were examined via principal components analysis using varimax rotation. Three items did not load on the first factor and were dropped from the composite external measure (Cronbachs $\alpha = .76$).

4.2 Manipulation check

Negative Affect. Critical to the present study was that participants actually perceive the negative feedback messages as negative in affect. As such, we tested the effectiveness of the negative feedback by determining the level of negative affect that the feedback generated. We conducted a series of paired samples t-tests. Significant mean differences between pre- and post-test measurements of PANAS-X were observed for the composited negative affect values, $t(116) = -2.126, p = .036$ as well as individual negative affect items including Upset, $t(114) = -5.74, p < .001$, Guilty, $t(114) = -2.252, p = .026$, Hostile, $t(114) = -4.041, p < .001$, Irritable, $t(114) = -2.52, p = .013$, Ashamed, $t(114) = -4.54, p < .001$, and Nervous, $t(114) = 3.495, p = .001$. Here, we see clear indication that the experimental negative feedback was generally successful in communicating its meaning and intent. Significant mean differences were also observed for the positive affect items of Enthusiastic, $t(114) = 2.62, p = .01$, Proud, $t(114) = 2.82, p = .006$, but the direction of the mean differences indicate a decrease in enthusiasm and pride, providing further support for that the negativity of the feedback was accurately perceived.

Experiment Authenticity. Another significant factor in the present study was the degree to which participants truly believed that the negative feedback they were receiving was tailored and specific to each person. Although efforts were made to make the virtual environment and authentic, some participants could pick up on the actual non-intelligent nature of the virtual environment. That is, although participants were (falsely) told that the virtual instructor would be tailoring their feedback to the participants performance, not all participants deemed the virtual environment to be authentic. As such, a manipulation check was delivered to the participants in the form of two items on a 7-point Likert scale (anchors extremely inauthentic and extremely authentic): To what extent did you feel that the instructor's feedback was authentic/real? and To what extent did you feel that the virtual environment was authentic/real?

Both items were normally distributed and no outliers were identified, enabling all participants to be included for analysis. Participants generally were mixed in their judgments of the authenticity of the instructor feedback (M= 3.92, SD = 1.7) and generally felt the virtual environment was more authentic than inauthentic (M = 4.43, SD= 1.5). Further, the medians for each of the two items were 5, which corresponds to Slightly authentic on the 7-point Likert scale.

Appearance and Audio. As this experiment only utilized 1 male and 1 female VH, a separate manipulation check was conducted to control for the appearance and voice of the Virtual Instructor. 178 participants were recruited from Amazon Mechanical Turk to judge 5 virtual humans (3 males, 2 females) for threat, likability, and attractiveness of virtual human with different appearances. Each participant was randomly assigned to rate 2 virtual agents repeating the same line, which was taken from the actual main experiment. The affect was evaluated by a Self-Assessment Manikin (SAM) scale and personality was assessed by using the same scale introduced in [33] by adding one more item, 'attractiveness'. We found no significant difference between the appearance and voice of 5 virtual agents which suggests that appearance and vocal quality have no significant impact on the participants' perceptions of explicitly harsh negative feedback.

4.3 Statistical analysis

CDSII. A 2-way MANOVA was conducted examining the effects of Proxemic Distance with the Gender of the Virtual instructor on the factor analyzed composite CDS II Dimensions of Locus of Causality, Personal Control, Stability, and External Control. A multivariate main effect of Proxemic Distance on the CDS Dimensions was observed, $F(4, 117) = 7.15, p < .001$, $r = .21$. No other main effects or interaction effects were found. Univariate main effects of Proxemic Distance were observed for Stability, $F(3, 117) = 20.69, p < .001$, $r = .16$, Personal Control, $F(3, 117) = 4.88, p = .029$, $r = .04$ and External Control, $F(3, 117) = 7.91, p = .006$, $r = .07$. No other main effects or interaction effects were observed. As each independent variable was limited to 2 levels, post-hoc tests were not conducted.

Regardless of Virtual Instructor Gender, those who interacted with a Close instructor reported significantly higher levels of External Control. In other words, the participants in the Close conditions tended to report that people outside of themselves (the professor) had a more impactful role in their performance. Further, those who interacted with a Close instructor reported significantly lower levels of personal control, or ones own ability to regulate and manage ones performance, as well as significantly higher levels of stability, deeming the current situation of negative feedback to be more permanent, stable, and unchangeable.

PANAS-X. Participant Gender was added to the MANOVA model to examine the 3-way effects of Proxemic Distance, Gender of the Virtual Instructor, and Participant Gender on the individual post-test measurements of PANAS-X.

As each independent variable was limited to 2 levels, post-hoc tests were not conducted. Univariate main effects of Participant Gender were found on items such as Interested, Excited, Enthusiastic, Inspired, Determined and Active, as shown in Table 2. That is, male participants generally reported greater positive affect than female participants after receiving the negative feedback. This indicates a presence of a gender-based pattern in which male participants seemingly bounce-back in reaction to harsh negative feedback.

Table 2. Main effect of Participant Gender on Post-test PANAS-X

Dependent Variable	df	Mean Square	F	Sig.	Partial Eta Sq
Interested	1	4.259	4.521	.036	.04
Excited	1	9.747	7.459	.007	.06
Enthusiastic	1	5.386	4.135	.044	.04
Inspired	1	12.671	8.395	.005	.07
Determined	1	11.032	8.68	.004	.07
Active	1	19.34	13.96	.000	.11

Ad-Hoc Items. A 3-way MANOVA was conducted examining the effects of Proxemic Distance, Virtual Instructor Gender, and Participant Gender on the individual Ad-hoc items. As the Ad-hoc items did not constitute a composite measurement scale, each item was examined at the univariate level. Univariate main effects of Proxemic Distance were observed for the helpfulness of the feedback, the likability of the professor and the level of effort put into the task, as shown in Table 3. That is, participants in the Close condition perceived the feedback to be less helpful, the professor to be less likable, and tried harder to complete the task than participants in the Far condition did. Further, participants in the Close condition attributed the professors reactions to his/her personality more so than those in the Far conditions, $F(3, 117) = 28.23, p < .001$, r = .20.

Table 3. Main effect of Proxemic Distance on Ad-hoc Items

Dependent Variable	df	Mean Square	F	Sig.	Partial Eta Sq
Helpfulness of the instructor's feedback	1	9.078	7.687	.007	.08
Accuracy of the instructor's feedback	1	2.676	2.928	.090	.02
Attribute to professors personality	1	88.264	28.226	.000	.20
Attribute to professor having a bad day	1	5.398	2.424	.122	.03
Level of Effort	1	23.509	27.460	.000	.22
Likability of professor	1	39.971	23.738	.000	.18

An interaction effect of Participant Gender and Proxemic Distance was observed for the level of effort placed on the acting task, $F(3, 117) = 5.304, p = .023$, r = .05. That is, male participants in the Close condition tried much harder on the task than the males in the Far condition. The difference in effort between Close and Far conditions was not as pronounced for the female participants.

Head Movement. A 3-way MANOVA was conducted examining the effects of Proxemic Distance, Virtual Instructor Gender, and Participant Genderthe aggregate and directional HMD movement on the x, y, and z axes.

Aggregate Head Movement (Bi-Directional). A multivariate main effect for Proxemic Distance was observed for HMD movement, $F(3, 105) = 2.983, p = .035$, r = .08. Further, a 2-way multivariate interaction effect was observed between Participant Gender and Virtual Instructor Gender, $F(3, 105) = 5.334, p = .002$. Finally, a 3-way multivariate interaction effect was observed for Proxemic Distance, Participant Gender, and Virtual Instructor Gender, $F(3, 105) = 2.994, p = .034, r = .13$. Univariate analyses revealed main effects of Proxemic Distance on x-axis movement, $F(1, 115) = 8.498, p = .004$, r = .07, and z-axis movement, $F(1, 115) = 4.105, p = .045$, r = .04. In other words, there was a significant difference in side-to-side movement (x) and front-back movement (z) depending on the Virtual Instructors Proxemic Distance. Proxemic Distance also impacted the up-down movement (y), but this main effect was not significant, $F(1, 115) = 3.069, p = .083$, r = .03. A univariate 2-way interaction effect between Participant Gender and Virtual Instructor Gender was observed on only the x-axis movement, $F(1, 115) = 9.598, p = .002$, r = .08. Male participants x-axis head movements shot up in response to interacting with a female virtual instructor, whereas female participants x-axis head movement declined when interacting with a male virtual instructor. No other significant univariate main effects or interaction effects were observed.

Directional Head Movement (Uni-Directional). A univariate main effect was observed for Proxemic Distance on HMD y-axis (up-down) movement direction, $F(1, 115) = 4.461, p = .037$, r = .04. In other words, participants tended to sink down in response to the Close distance conditions relative to the Far distance conditions.

Further, a univariate 3-way interaction for Proxemic Distance, Virtual Instructor Gender, and Participant Gender was observed on HMD z-axis (towards-away) movement direction, $F(1, 115) = 5.41, p = .022$, r = .05. In other words, a two-way interaction varies across different levels of a third variable. Fig. 2(a) depicts the 2-way interaction for Proxemic Distance and Virtual Instructor Gender for Male participants and Fig. 2(b) depicts the 2-way interaction for Proxemic Distance and Virtual Instructor Gender for Female participants. Male participants tended to move forward when they interacted with a male virtual instructor at a close distance relative to those who interacted with a male virtual instructor at a far distance. Conversely, male participants interacting with a female virtual instructor at a close distance tended to move backwards relative to male participants interacting with a female virtual instructor at a far distance. As shown in Fig. 2, this identical pattern of forward-movement in response to same-gendered virtual instructors and backward-movement in response to cross-gendered virtual instructors at a close distance was also observed among female participants. No other main effects or interaction effects were observed for the above variables.

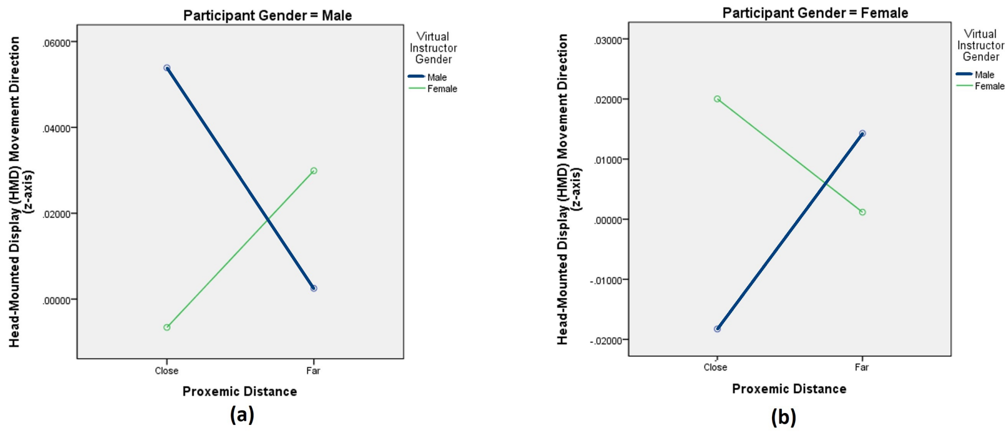

Fig. 2. 2-way Interaction for Proxemic Distance and Virtual Instructor Gender across Male (a) and Female Participants (b) (3-way Interaction)

5 Discussion

Attribution and Affect To begin, the current study lent partial support to our attribution-related hypotheses. Negative feedback at a close distance led to greater judgments of external control and less personal control over one's performance, providing support to the prediction that negative feedback at a closer distance would exacerbate feelings of "learned helplessness" [13]. That said, contrary to predictions based on literature [29–31](Bar Tal, 1978; Frieze, 1975; McMahan, 1973)., no significant gender effects of attribution were observed. A concept closely tied to attribution is motivation. At a fundamental level, negative feedback has been shown to lower motivation [14]. That said, students may employ strategies to counteract the negative feedback, such as increasing effort [15] and lowering goals and expectations [12]. As such, a more complete understanding of attributional tendencies warranted more detailed adhoc analysis of participants' judgments of the instructor and the feedback. Although participants in the close conditions perceived the instructor to be less likable and the feedback to be less helpful, they did report trying harder in the task than did participants in the far condition. As observed as by the PANAS-X and Ad-Hoc Measure results above, the close distance seems to raise the degree of accountability in the task particularly for male participants, who demonstrate a sizable drop off in effort when interacting with a Far virtual instructor. This pattern of behavior somewhat corroborates the above tendency for the male participants to be being more interested, excited, enthusiastic, determined, and active in response to the instructors negative feedback.

Unexpectedly, however, we found a pattern of mixed affect-related reactions to negative feedback delivered at a close distance– particularly among male participants. Specifically, we found that that negative feedback at a close distance raised various components of positive affect among male participants, who reported significantly higher levels of interest, excitement, enthusiasm, determined, and activity.

While the manipulation check of the negative affect reinforced the notion that participants reported significantly greater negative affect after the experiment, male participants exhibited a curious pattern of asserting what may be categorized as a defiant resilience, and a refusal to be negatively impacted by the criticisms. This pattern of behavior may be explained by the tendency of negative feedback to enforce a sense of accountability, thereby generating the attention and motivation needed to complete the task successfully.

A small twist in this affective response of male participants was that male participants seemed to report feeling far more irritated by instructors providing negative feedback at a far distance than close distances, whereas the inverse effect was seen among female participants. The male effect may be attributable to the cognitive dissonance experienced with an extremely critical message coupled with a perception of a less engaged body language (far distance). This irritation experienced by male participants is likely associated with the tendency for male participants to try harder on the task in the close conditions.

Head Movement. Finally, in order to examine the reactionary physical behaviors of participants in response to varying proxemic distance, we examined two types of head movment across 3 different coordinate-planes. We observed gendered differences in Head Movement in reaction to the Close and Far distance conditions. Specifically, male participants cumulative side-to-side head movements shot up in response to interacting with a female virtual instructor, whereas female participants' side-to-side head movement declined when interacting with a male virtual instructor. More interestingly, all participants in Close conditions - regardless of gender - exhibited a tendency to move forward in response to a same-gendered VH while moving backwards in response to a cross-gendered VH. This result adds complexity to our original hypothesis that participants would generally move backwards in response to a Close VH. A forward-movement, or leaning- of the head over the course of the experiment may suggest an in-group/out-group phenomenon where participants are less comfortable and/or less focused when receiving negative feedback from a same-gendered instructor.

Limitations and Future Directions. Future research should be done into examining the specific gender-specific patterns observed here. Notably, head movement has not previously been associated with proxemics/interpersonal distance, but the implicit nature of these fine-grained head movements may be reliable measurement of proxemic effects moving forward – potentially having greater implications for how we study the basic components, effects, and perceptions of social interactions and situations.

Recall that we performed a manipulation check of VH appearance and voice that used video clips as opposed to the experience in the VR experiment. The use of these separate modalities may potentially weaken the impact of the manipulation check. Future studies would ideally run the full VR-environment experiment using a range of virtual human characters that account for the variability in human appearance and voice.

Finally, a significant limitation to this study is a lack of a true control where the negative feedback is more muted or non-existent. The presence of such a control condition could allow for a stronger argument about the effects found in this study – particularly the resilient "bounce-back" effect observed among male participants.

6 Conclusion

Why do drill sargeants and sports coaches often use harsh feedback? All together, this study provides a keener understanding of the varying effects of negative feedback that could potentially have positive outcomes– particularly when delivered from a close proximal distance. Indeed, negative feedback has been observed to act as a motivator for tasks that are required [34]. The findings suggest a gendered pattern in reaction to negative feedback as male participants seem to demonstrate a "bounce-back" effect in response to the negative feedback by trying harder, feeling more positive, and moving even closer to the instructor.

This project has broad implications for pedagogy, mental health, decision-making and skill-based training. For instance, these findings may enable researchers to develop a keener understanding of how participants respond, both verbally and physiologically, to the experience of negative feedback. This information can then be used to create intervention strategies to "buffer" participants against the instructor's negative feedback: These student tactics could be taught through successive iterations of the virtual scene. By simulating a negative feedback teaching situation in a virtual environment, we present the potential for a more precise understanding of the effects of negative feedback on students' learning, emotional state, attribution patterns, and even their nonverbal reactions to the negative feedback. We suggest further inquiry into different social situations and contexts in order to develop and strengthen these arguments.

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