

Interface agents to alleviate online frustration

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Abstract: Mitigating system-based frustration is important within computer-based learning contexts. In two experimental studies, students answered online survey items and were confronted by a frustrating obstacle—an error message pop-up window that blocked them from answering the items. In the first study, “Survey Sam,” an animated interface agent was present throughout the survey, and at the end delivered an affective message (apologetic or empathetic) or remained silent. Results revealed that the presence of either message led students to attribute the cause of their frustration to the program instead of to themselves. Further, participants receiving the empathetic message rated Survey Sam as significantly more believable and sincere. The second study investigated the impact of the visual presence of the agent by providing identical messages but with voice only. Results reinforced the value of the agent’s visual preference as more effective than voice only, particularly for the empathetic message.

Introduction

Emotions within learning contexts are not stable. Students may experience many different emotional states during the learning process. According to appraisal theories of emotion, emotions arise from an individual’s meaning construction and appraisal of continuous interactions with the world (Frijda, 1986; Lazarus, 1991). Especially in learning situations, the process of students’ meaning construction and appraisal may acquire different forms depending on the characteristics of the tasks given to those students. Frustration, where an obstacle prevents the satisfaction of a desire (Barker, 1938), is one of the negative emotions students deal with in most learning situations because a learning task usually requires student effort to solve challenging problems. Therefore, reducing the level of frustration becomes a critical issue in a computer-based learning situation (Bias & Mayhew, 1994). One method for diffusing frustration involves offering an *apology*, especially if the one apologizing is taking responsibility for the obstacle causing the frustration, thus admitting blameworthiness and regret for an undesirable event (Darby & Schlenker, 1982; Blum-Kulka, House & Kasper, 1989). A second method to diffuse frustration involves delivering *empathetic concern* for another’s emotional experiences, especially if the one expressing concern is not perceived as the cause of the frustration. Empathy is an emotive-cognitive state where the emotional element involves concern with the personal distress of another person and the cognitive element involves understanding the perspective of the other person (Rogers, 1980), resulting in a shared, or distributed, emotional experience.

With regard to previous agent implementations, Mori and colleagues evaluated an affective agent that was designed to alleviate frustration during a mathematics quiz game by delivering empathetic “happy for” or “sorry for” responses (Mori, Prendinger, & Ishisuka, 2003); however, results were limited by a small sample

size. While Johnson and colleagues have found that agent politeness is valuable in a tutoring environment (Wang, Johnson, Rizzo, Shaw, & Mayer, 2005), they have not focused on learner frustration. Baylor and colleagues investigated the role of interface agent message (presence/absence of motivation) and affective state (positive versus evasive) on student attitude for mathematically-anxious students (Baylor, Shen, Warren, & Park, 2004). While their results supported the value of cognitively-focused motivational messages (e.g., Bandura, 1997) on student confidence, results were inconclusive regarding the impact of affect as a mediator in the process.

Experiment 1

The first experimental study was designed to investigate the impact of interface agent message (apologetic, empathetic, or none) on student frustration, attribution perception, and attitude. Specifically, we investigated the following research questions:

1. Does the presence of an affective message impact participant attitude toward the task, attitude toward the agent, or attribution toward the cause of frustration?
2. Does the type of affective message (apologetic or empathetic) impact participant attitude toward the task, attitude toward the agent, or attribution toward the cause of frustration?

Method

Participants

Participants included thirty undergraduate students (average age = 19.7 years; 93% female) who had recently completed an introductory course on Educational Technology in a public university in the Southeastern United States. Fifty-five participants began the study, but only thirty actually completed it. Computer self-efficacy assessed as part of the pre-survey revealed no differences in efficacy between those who completed the survey and those who did not, or between treatment groups.

Research Environment and Interface Agent

The research environment was created so that participants could complete a personality survey (based on the Big Five Factor theory of personality (e.g., Costa & McCrae, 1992) with the presence of “Survey Sam,” a 3D animated interface agent. Upon entering the environment, Survey Sam introduced students to the survey, stating: “Hi, my name is Survey Sam. Here’s the survey you take to get your movie tickets. Please do your best.” While students were completing the survey, Survey Sam was always present and displayed basic animations, including eye-blinking and head-turning, figuratively “watching” participants as they worked through the survey. His presence was maintained throughout the survey to establish his existence as a foundation for the message that he later delivered to 2/3 of participants. Upon completion of the survey (for the thirty students, or 52%, who actually finished it), Survey Sam was either silent or provided one of two affective messages with a human voice: apologetic or empathetic. The script for the apologetic agent was based on the strategies in the Cross-Cultural Speech Act Realization Project (Blum-Kulka, House, & Kasper, 1989) and the script for the empathetic agent paralleled the apologetic script based on Roger’s (1980) emotive-cognitive description of empathy. Table 1 lists the scripts used in this study.

Table 1. Scripts for Apologetic and Empathetic Messages

Message	Scripts
Apologetic	<i>"I'm really sorry that this problem happened to you. I know that the problem could have been avoided on our part, and it was not your fault. I promise that I will report this problem to the system administrator so that it will never happen again. Please take a few minutes to describe your experiences from the previous screens. Thank you."</i>
Empathetic	<i>"It must have been very frustrating trying to finish the survey with the problem you were experiencing. I sympathize with how you feel. I wish that I could have helped you to overcome this problem. Please take a few minutes to describe your experiences from the previous screens. Thank you."</i>

Post-survey

The post-survey assessed the dependent variables of agent competency, agent believability, survey enjoyment, survey frustration level, and attribution of the cause of the frustration. Agent competency and agent believability measures were adopted from the API (Agent Persona Instrument) developed by Ryu and Baylor (2005). Three to five items were used to measure each dependent variable and each employed 5-item Likert scales. Internal consistency reliabilities (Cronbach's alpha) for Agent competency, Agent believability, Survey enjoyment, and Survey frustration level measure were .90, .74, .98, .88, and .75, respectively.

Procedure

A total of 289 emails were sent out to invite students to participate in a web-based personality survey and receive a free movie ticket upon completion. Respondents could complete the survey within the following four weeks. The 55 participants who began the survey first provided demographic information and information regarding their computer self-efficacy. Following this, they completed items from the Big Five personality survey, as presented on five successive screens, with eight items per screen. Beginning on the second screen of the Big Five survey, a pop-up window appeared and covered up the survey items (see Figure 1). This pop-up window was designed to stimulate annoyance and frustration in the participants. The participants had to move the pop-up window out of the way in order to answer the survey questions (the window would not close by pressing the red "X" button). Because the pop-up window moved back to the original spot after five to nine seconds, participants had to repeatedly move the pop-up window out of the way to respond to the survey. Indeed, this was such a frustrating experience that only 30 of the initial 55 participants completed the survey.

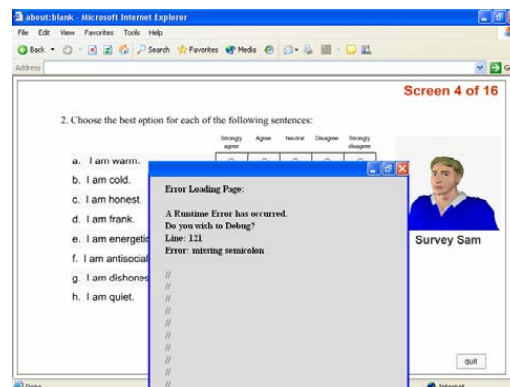


Figure 1. Screen shot with the pop-up window as an obstacle to answer survey questions

After completing the personality survey, the agent was either silent or provided an affective message (apologetic or empathetic). Next, students completed a post survey to assess agent competency, agent believability, survey enjoyment, survey frustration level, and attribution of the cause of the frustration.

Data analysis and design

A planned contrast with alpha level set at .05 was conducted to compare each dependent variable between those receiving no message (silent agent) and those receiving an affective message (either apologetic or empathetic). An independent sample *t*-test with alpha level at .05 was conducted to compare each dependent measure between the apologetic-message and empathetic-message groups. Students' perception of attribution of problem cause was analyzed with a one-way ANOVA, across the three agent conditions (silent, apologetic, empathetic).

Results

Impact of affective message

The primary research question in this study was concerned with the effect of interface agent message (or absence). The descriptive statistics for each dependent variable are presented in Table 2.

Table 2. Means and standard deviations of dependent variables across groups.

Message	Agent Competency		Agent Human-Like		Agent Believability		Survey Enjoyment		Survey Frustration	
	M	SD	M	SD	M	SD	M	SD	M	SD
Apologetic (n=11)	3.18	.68	3.00	.51	3.00	.94	3.25	.96	3.24	.82
Empathetic (n=9)	2.78	.93	2.78	.83	3.89	.60	3.06	.1.09	3.15	.94
Silent (no message) (n=10)	3.22	.47	2.85	.39	3.23	.39	3.33	.53	2.23	.93

For survey frustration, results indicated a statistically significant difference between those receiving an affective message and those receiving no agent message, $t(27) = 2.772$, $p=.01$, $d=1.12$, a large effect, indicating that students who received an agent message reported significantly higher frustration from taking the on-line survey than students who did not receive a message.

Independent sample *t*-tests with alpha level at .05 were conducted to compare each dependent variable between participants receiving an apologetic versus empathetic message. Results revealed that for agent believability there was a statistically significant difference between the apologetic-message group and empathetic-message group, $t(18) = -2.445$, $p<.05$, $d=1.16$, a large effect, indicating that students in the empathetic-message group believed the animated agent more (e.g., believed that Survey Sam “meant what he said,” and “was sincere in what he said”) than students in the apologetic-message group.

Attribution of cause of problem

Students also rated their attribution of the cause of the problem. Descriptive statistics for the attribution of problem cause are presented in Table 3.

Table 3. Descriptive statistics for attribution of problem cause

Students attributed the malfunction to...								
Message	Themselves		Survey Sam		Software		Internet	
	<i>M</i>		<i>M</i>		<i>M</i>		<i>M</i>	
	<i>SD</i>		<i>SD</i>		<i>SD</i>		<i>SD</i>	
Apologetic (n=11)	1.82	.75	3.00	1.27	3.82	1.08	3.09	1.14
Empathetic (n=9)	1.56	.73	2.00	1.00	4.22	.83	2.67	1.32
Silent (no message) (n=10)	2.50	.53	2.90	.74	3.60	.70	3.30	.68

(Range of 1-5, where 1=SD and 5=SA)

A one-way ANOVA setting the alpha level at .05 was conducted to examine whether students attributed the cause of the problem to themselves, to Survey Sam, to the computer software, or to the Internet. The ANOVA yielded a significant overall difference, $F(2,29) = 5.03$, $p < .05 = .27$. Follow-up Fisher's least significant difference (LSD) tests were performed to determine whether significant differences occurred between the mean scores for each pair of treatments. These tests revealed that those in the silent agent (no message) group tended to attribute the problem to themselves more than the other two message groups ($p < .05$). There was no statistically significant difference between the apologetic-message agent group and the empathetic-message agent group. The ANOVA was also conducted to determine whether there were differences between groups in attributing the cause of the problem to Survey Sam. As expected, those receiving an apologetic message tended to attribute the problem to Survey Sam ($p < .05$). This validated the treatment, as it indicates that participants believed Survey Sam when he apologized and took responsibility for the problem.

Discussion

Results indicate that the presence of an affective message contributed to participants reporting significantly greater frustration. This indicates that they resonated with and believed the agent, as his message essentially "re-activated" their frustration, validating it and amplifying it. More importantly, students who received the agent's affective message also tended to attribute the cause of the frustration to the program (rather than themselves). Given that the problem was indeed out of their control, implementations like this that can reassure students that they are not at fault are of importance; indeed, this was only a five-sentence intervention, yet it yielded large effects (over a standard deviation). Future research should consider the nature of this self-reported "frustration" and its relative weight in relation to students' attributions of the cause. Results also indicated that students who received the empathetic message rated the agent as more believable than students in the apologetic-message group. Since the empathetic message conveyed an understanding of the student's perspective rather than focusing on responsibility, it may have had the effect of making the student feel that he/she and the agent were figuratively "in the same boat." This might have provided the student with the perception of the interface agent as an understanding bystander instead of a responsible/apologetic or non-responsive helper. Also, the delay of the apology from the initial occurrence of the problem may have lessened the credibility of the apologetic message in terms of perceived sincerity. In addition, an apologetic message that conveys responsibility for the problem may also place the agent in an inferior position, i.e., the agent may be perceived as someone who has failed in avoiding technical problems. Either way, it is interesting that such a brief message from a non-human, computer-based, interface agent had such a profound impact, in line with findings by Reeves and Nass (1996).

In retrospect, given that 25 of the 55 respondents who began the survey did not finish it (a 45.5% attrition rate), the survey was likely *too* frustrating. Another limitation is that the experiment had a low number

of participants per condition (9, 10, and 11 respectively). However, in spite of the relatively low statistical power, the results were statistically significant with large effect sizes ($d > 1.0$). Another important consideration is that participants completed the study at their own computer and chosen time/place. While control in implementation was thus lost, ecological validity was enhanced, as this type of computer-based frustration is more authentically simulated in a real context. Despite these limitations, the overall impact of these findings is that the presence and nature of an agent-delivered affective message can impact how a student perceives frustration. However, a lingering question from this initial study was: what was the actual impact of the *interface agent* in leading to these outcomes? Thus, a second study was conducted, with two control groups to examine the impact of the visual presence of “Survey Sam” in delivering the message versus voice-only message delivery.

Experiment 2

Participants

Participants included undergraduate students (average age = 20.2 years). Sixty participants began the study, but only twenty-five actually completed it. Computer self-efficacy assessed as part of the pre-survey revealed no differences in efficacy between those who completed the survey and those who did not, or between treatment groups.

Procedure

For this study, “Survey Sam” was not visually present on the screen, but he provided, using voice only, one of the two messages (empathetic or apologetic) which were identical to the first study. The procedure was identical to that in the first study in all other ways.

Data Analysis and Design

Two planned independent sample *t*-tests with alpha level of .05 were conducted to compare each of the agent-delivered messages (empathetic and apologetic, from Experiment 1) with the voice-delivered messages for each of the dependent measures.

Results

Results indicated significant differences between the agent-delivered empathetic message and the voice-delivered empathetic message in two areas. First, participants reported that the empathetic “Survey Sam” was significantly more believable when he was visually present ($M=3.89$, $SD=.20$) than absent ($M=2.83$, $SD=.41$, $p<.05$). Second, participants were significantly more likely to attribute the frustration/problems they experienced to the computer software when “Survey Sam” was visually present ($M=4.22$, $SD=.28$) than absent ($M=2.83$, $SD=.44$, $p<.01$), with a large effect size ($d > 1.0$). With respect to the comparison of the agent-delivered apologetic message versus voice-delivered apologetic message, there were no significant differences.

Overall Discussion

The second study revealed that for the empathetic message in particular, the visual presence of “Survey Sam” was particularly powerful. Specifically, as compared to the voice-only condition, the visually present agent led to significantly more positive outcomes with respect to student attribution of source of frustration and believability of message. While there were no significant differences between agent presence/absence with respect to the apologetic message, this is supportive of results from the first study, where it was also found less effective than the empathetic message. Interestingly, the visual presence of the interface agent, “watching” the

participant experiencing frustration and then providing an empathetic message, was the most powerful of all the interventions. This contributes to increasing evidence that interface agents can serve as believable virtual “peers” to which students respond affectively (Baylor & Plant, 2005; Kim & Baylor, in press). These findings are important because they suggest that the presence and nature of an affective message can powerfully impact how a student perceives frustration, and provide the catalyst for further research in the development of frustration-mitigating support for computer-based contexts.

While learner frustration is not always detrimental, and can in fact be a valid part of the learning process (Kort & Picard, 2001), it is important to continue to investigate alleviating learner frustration that is extraneous to the learning process (e.g., system-related). Future research should consider the timing of the message, including messages delivered during each problem occurrence rather than after-the-fact. Future studies could also track student interactions to determine when participants quit during a frustrating task, as well as compare participant personality characteristics with their frustration levels, attribution perceptions, and attitudes.

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Acknowledgments

This work was supported by the National Science Foundation, Grant IIS-0218692.