Tough Love: The Influence of an Agent’s Negative Affect on Students’ Learning

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Abstract. In this paper we explored the relationship between learning gains and affective displays of an animated pedagogical agent. Students read information on the topic of computer literacy while receiving either positive or negative affective responses from an on-screen animated agent. Analyses revealed that only students with low prior knowledge were influenced by the emotion displayed by the animated agent. We discuss the generalizability of our findings to other domains and the implications of these results on intelligent tutoring systems that are emotionally intelligent.

Keywords. Emotion, affect, animated agents, prior knowledge

Introduction

Does an emotionally expressive animated agent influence the way in which students learn complex scientific material? In recent years, the connection between affect and complex learning has received increased attention from researchers in the fields of psychology [1], education [2], neuroscience [3], and computer science [4]. Machines are also now being given the ability to appear empathetic or otherwise emotionally intelligent [5]. Because computers are ubiquitous, at first glance this would seem like a step in the right direction. However, few researchers have explored the possible consequences of having students learn from animated agents that are capable of displaying affect. Additionally, some researchers have explored what role individual differences play when using a multimedia environment to learn complex scientific material [6]. One of Richard Mayer’s principles called “the individual differences principle” states that design effects are stronger for low knowledge learners than for high knowledge learners, and for high spatial learners rather than low spatial learners.

In this paper we explore the novel relationship between an animated agent displaying emotions and students’ learning gains. More specifically, we focus on two important research questions. First, are there significant differences in learning gains between students who observe an animated agent displaying positive emotion versus students who observe an animated agent displaying negative emotion? Second, are students with varying levels of prior knowledge on a topic impacted differently by observing a positive or negative animated agent?

Some of the available research suggests that positive affect may be beneficial at facilitating particular tasks. For example, Isen, Daubman, and Nowicki [7] conducted
an experiment directly comparing the potential benefits of positive vs. negative affect on two tasks of creativity. Analyses indicated that the participants in the positive affect condition were able to generate significantly more correct solutions than the participants in the negative affect condition. According to the research conducted by Isen et al. we would expect our participants that receive the positive affect during the presentation to show significantly higher posttest scores than participants in the negative affect condition.

Alternately, participants that only receive positive affect might fall prey to the “illusion of knowing” effect [8]. That is, participants incorrectly believe they are understanding the material, and this view is reinforced by the positive affect from the agent. Since it requires some expertise for learners to know that they do not understand something [9], this effect could be more pronounced for low knowledge learners. However, a negative affective response might deemphasize the effect. A negative response or feedback from the agent should cause the learner to question what they know sending the learner into momentary cognitive disequilibrium [10] and benefit learning. According to the “illusion of knowing” effect, we would expect participants that receive negative affect throughout the presentation to show significantly higher posttest scores than the participants in the positive affect condition.

1. Methods

Participants (N = 29) were drawn from introductory psychology classes at a large mid-south university. Participation met a course requirement. The experiment included both paper-and-pencil and computerized materials. The paper-and-pencil materials, used to evaluate pretest to posttest learning gains, consisted of two multiple-choice tests. The two tests each comprised 24 four-alternative deep-level questions. The two tests were counterbalanced as pretest and posttest. The computerized sessions were created using Microsoft PowerPoint and consisted of 77 slides containing information on 12 topics of computer literacy. At the beginning and end of each of the 12 subtopics, an animated agent appeared on the screen and displayed either a positive facial emotion or negative facial emotion depending on the condition. The animated agents and emotions were designed using the Haptek agent design facility.

Each participant was randomly assigned to one of two conditions (positive affect vs. negative affect) when they arrived at the laboratory. Immediately after the demographics questionnaire and informed consent were obtained, the pretest was administered. It was followed by the computerized session (which lasted approximately 25 minutes), then the posttest, and finally debriefing. Proportional learning gains were computed using the formula (posttest-pretest)/(1 – pretest).

2. Results & Discussion

Analyses revealed no significant differences between the groups \( t (27) = -.79, p > .05 \). Agent emotions had no impact on the high knowledge students (See Table 1). A t-test was conducted on the low prior knowledge students to determine any significant differences between the groups. Analysis exhibited a one-tailed significant difference between the low knowledge students in the positive affect condition (\( M = .34 \)) and the low knowledge students in the negative affect condition (\( M = .45 \)), \( t (13) = .92, p < .05 \).
Table 1. Means (SD) for change scores as a function of prior knowledge and agent affect

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Positive Affect</th>
<th>Negative Affect</th>
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<tbody>
<tr>
<td>Low</td>
<td>.34 (.14)</td>
<td>.45 (.10)</td>
</tr>
<tr>
<td>High</td>
<td>.14 (.25)</td>
<td>.16 (.15)</td>
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</table>

Analyses revealed that students who entered the session with low prior knowledge on the topic of computer literacy were most influenced by receiving affect from the pedagogical agent. This finding is consistent with other research that shows that low ability students are most influenced by these pedagogical design principles [6]. However, an unexpected finding was that the low knowledge students benefited the most by receiving negative affect from the animated agent. This finding can be explained, in part, to the “illusion of knowing” effect [8]. Students typically have the misconception that they understand material when in fact they do not. By giving low knowledge students positive affect, regardless of their performance, we are reinforcing their belief that they are performing well. This “illusion of knowing” effect can be seen in the students low change scores. However, by giving students negative affect, the “illusion of knowing” effect seems to be mitigated. Students are under the impression that they are performing well until they receive a “negative response” from the animated agent which puts the students in a temporary state of cognitive disequilibrium which promotes inquiry and questions [10]. However, it was also discovered that high knowledge students were not influenced by either emotion. High knowledge students could be using their prior knowledge to compensate for the lack of guidance in the presentation.

References