Surrogate Embodied Learning in MUVEs: Enhancing Memory and Motivation through Embodiment

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Abstract: We investigated the effects of positive embodied affect and embodied learning environments on adult learners' memory of novel historical text, motivation, near transfer, and far transfer. Participants were randomly assigned to three types of learning environments: Surrogate Embodiment in a multiuser virtual environment (MUVE), Imagined Embodiment, and No Embodiment. Half the participants in each learning condition received a positive Embodied Affect manipulation while the other half (control) did not. The results revealed significant main effects for Embodied Affect and Type of Learning Environment. The results suggest that (a) Surrogate Embodiment enhances memory, motivation, near transfer, and far transfer more than No Embodiment; (b) Surrogate Embodiment enhances memory, and near transfer more than Imagined Embodiment; and (c) positive Embodied Affect with Surrogate Embodiment further enhances memory and transfer.

One Sentence Summary: Our pilot study results suggest that embodied affect and surrogate embodiment in MUVEs enhance learning and motivation.

Introduction

Embodied learning implies that our bodies and bodily movements influence the way we think, speak, remember and learn [1]. Embodied cognition theories propose that since embodiment enables the production of mental simulations [2, 3, 4], embodiment facilitates memory and comprehension of text [5, 6]. Research findings suggest that embodied learning environments enhance memory, motivation, and transfer of learning more than traditional learning environments [4, 7, 8, 9] and positive embodied affect enhances memory and comprehension [9, 10].

Embodiment of emotional affect refers to physically performing an action associated with the physical manifestation of affect. Research findings suggest that positive embodied affect induced by the physical act of using facial muscles to produce a smile [11] leads to the production of positive affordances, which enhance memory and comprehension [10]. Various types of embodied learning environments have been investigated by researchers, among which are surrogate embodiment and imagined embodiment. Surrogate embodiment refers to physically manipulating an agent, which has been designed to represent a particular object or person and imagined embodiment refers to consciously engaging one's imagination to mentally picture movement or action [4].

Based on embodied cognition theories and research on embodied affect and embodied learning, we conducted a pilot study to investigate the effects of positive embodied affect and embodied learning environments on adult learners' memory retrieval of novel historical text, motivation, near transfer of learning to the same domain (i.e., history) and far transfer of learning to a different domain (i.e., literature). For the purpose of this study, we defined a learning environment as one that provides learners the opportunity to engage in a learning task. The types

of learning environments investigated were (a) Surrogate Embodiment via avatar role-play in the MUVE *Second Life* [please refer to the official language] using the Teachers College island *TC Educator*, (b) Imagined Embodiment, and (c) a read-only No Embodiment (control).

Method

Participants. Sixty-six adult female (64%) and male (36%) graduate students volunteered to participate in the study for course credit. Participants' age ranged from 21 to 50 years. Most (74%) were 21-30 years old. 42% participants were 21-25 and 32% were 26-30 years old. Participants identified themselves as Caucasian (56%) and other diverse ethnicities (44%). Most participants (85%) had not taken history as a major in B.A. and only a small number (9%) of participants reported that they were familiar with some Indian history. However, they were not familiar with the text given to them.

Design. The study was designed as a 2x3 factorial posttest-only control group design with two factors: (a) positive Embodied Affect with two levels: positive Embodied Affect (EA) and No Affect (NA), and (b) Type of Learning Environment (TLE) with three levels: Surrogate Embodiment (SE), Imagined Embodiment (IE), and No Embodiment (NE). See Table 1. The dependent variables were memory retrieval measured via a memory retrieval test, near transfer of learning (to history) measured via a near transfer test, far transfer of learning (to literature) measured via a far transfer test, and motivation measured via items on a questionnaire.

	Surrogate Embodiment (SE)	Imagined Embodiment (IE)	No Embodiment (NE)
Embodied Affect (EA)	EA-SE	EA-IE	EA-NE
No Affect (NA)	NA-SE	NA-IE	NA-NE

Table 1. 2x3 Between-subjects Factorial Design - Six Groups

Apparatus and Materials. Apple MacBook Pro laptops were provided to participants in the Surrogate Embodiment (SE) groups. Participants assigned the Embodied Affect (EA) manipulation were provided with a sanitized brand new pen. Participants in the Imagined Embodiment (IE) groups were provided a sheet of A-4 size blank paper to write down what they imagined.

Pre-measurement materials used for manipulations included (1) an Autobiographical Memory Recall (AMR) Task Form, (2) historical text about the life of the Mughal emperor of India, Humayun, (3) color illustrations of the main characters in the historical text, (4) role-play script for avatars in the MUVE, and (5) observation sheet for role-play in the MUVE. A script was also used for a distraction task. Measurement materials included: (1) a memory retrieval test, (2) a near transfer test, (3) a far transfer test, and (4) a questionnaire. All measurement materials were printed on paper, and participants were required to either write their responses or select the appropriate response from a list of options provided.

The memory retrieval test consisted of twenty (open-ended and close-ended) questions on the life of the Mughal emperor Humayun. The maximum score for the test was thirty, and a higher score implied better immediate recall. The questions spanned the entire text about the emperor and they tested participants' immediate recall of facts, chronology, names of characters, main events, geographical and cultural information, and the relationship of the characters with the main character, etc.

The near transfer test was designed to test participants' transfer of learning to the same domain (i.e., history) to determine if participants could apply the knowledge they had acquired to another text from history. The test contained text about the life of the Queen of Jhansi who led a revolt in 1857 against the British at Jhansi in India. The text was followed by two open-ended questions that required participants to list similarities and differences between Humayun and the Queen of Jhansi.

The far transfer test, designed to test participants' transfer of learning to a different domain (i.e., literature), contained an excerpt from Birbal's stories, which are from Indian literature. The text was followed by two open-ended questions that required participants to list similarities and differences between Humayun and Birbal. Participants were asked to list as many similarities and differences as they could think of for both transfer tests. Scoring rubrics were developed for both transfer tests. One point was assigned for each response correctly inferred from the text within the cultural context. The maximum score for each test was twelve, and a higher score implied better transfer. Two independent raters scored the tests.

Five motivation items in the questionnaire were used to measure total motivation score. Participants were required to respond to the items on a five-point likert scale which ranged from strongly agree to strongly disagree. The items measured participants' confidence, enjoyment, increased interest in content, increased motivation to learn, and overall motivation. The maximum score for each item was five and the minimum was one. The maximum score for motivation was twenty-five, and a higher score implied higher motivation.

Procedure. After the informed consent process, half the participants received an Embodied Affect (EA) manipulation designed to induce positive affect by recalling a positive autobiographical memory while they held a pen sideways between their teeth producing a smile.

The manipulation was based on Strack, Martin, and Stepper's facial feedback hypothesis pen manipulation [11]. After this participants were given the Type of Learning Environment manipulation. Half the participants received No Affect (NA) and they proceeded directly to the Type of Learning Environment. For the Type of Learning Environment manipulation, all participants were given the same historical text about Humayun, the Mughal emperor, printed on paper along with color illustrations of the main characters. After reading silently, participants received different instructions depending on their group. Participants in the Surrogate Embodiment (SE) groups role-played in *TC Educator* as Humayun's avatar. The participants' avatar interacted with the avatar of Shah Tahmasp, a character from the historical text (see Figures 1 and 2). The same script was followed for each session. Participants used gestures, chat and movements in the role-play sessions. The Imagined Embodiment (IE) groups were instructed to imagine the actions in the text while reading and the No Embodiment (NE) groups were instructed to read the text once, and then they re-read it to control for time.

Manipulations were followed by the memory retrieval test, distraction task (a brief conversation between the participant and researcher), near transfer test, far transfer test, and questionnaire, which contained manipulation checks, motivation measures, and items designed to gather data about participants' backgrounds, prior knowledge, interests, and attitudes. At the end, all participants were asked questions to get their feedback. The feedback time was also utilized to debrief participants.

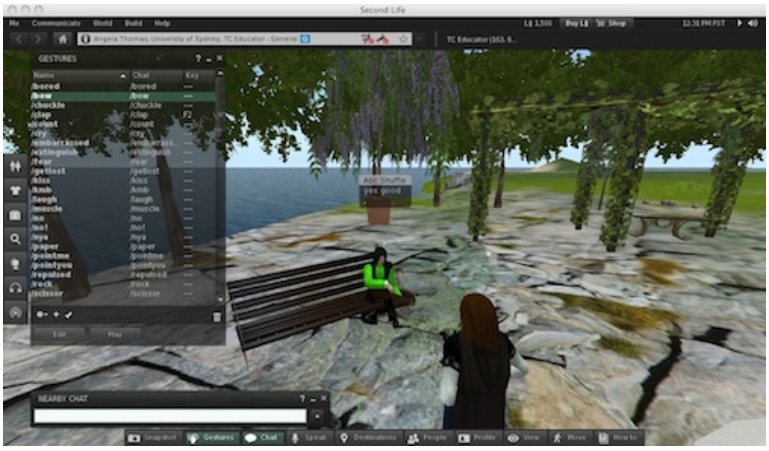

Figure 1. Role-play Activity in TC Educator, the Teachers College Island.

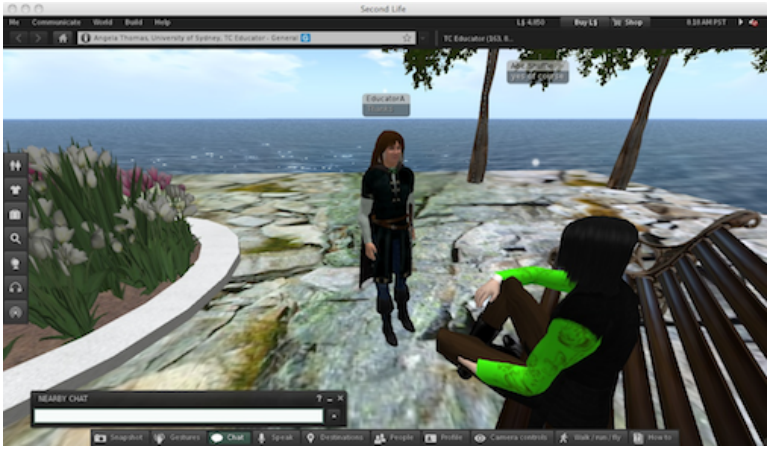

Figure 2. Humayun's Avatar Chatting with the Avatar of Shah Tahmasp of Persia.

Results

Multivariate Analysis of Variance (MANOVA) results revealed significant main effects for Embodied Affect (EA), Wilks' $\Lambda = .72$, $F(4, 57) = 5.50$, $p = .001$, $\eta 2 = .28$ and Type of Learning Environment (TLE), Wilks' $\Lambda = .43$, $F(8, 114) = 7.55$, $p < .001$, $\eta 2 = .35$. No significant interaction was found between Embodied Affect (EA) and Type of Learning

Environment (TLE), Wilks' $\Lambda = .86$, $F(8, 114) = 1.08$, $p = .38$, $\eta 2 = .07$.

Univariate tests results revealed that Embodied Affect (EA) had significant main effects on memory retrieval, $F(1, 60) = 12.57$, $p = .001$, $\eta 2 = .17$, and near transfer, $F(1, 60) = 10.60$, $p = .002$, $\eta 2 = .15$. Univariate results also revealed significant main effects for Type of Learning Environment (TLE) on memory retrieval, $F(2, 60) = 28.31$, $p < .001$, $\eta 2 = .49$, near transfer, $F(2, 60) = 11.60$, $p < .001$, $\eta 2 = .28$, far transfer, $F(2, 60) = 5.31$, $p = .008$, $\eta 2 = .15$, and motivation, $F(2, 60) = 8.31$, $p = .001$, $\eta 2 = .22$.

Mean vectors were found to differ across groups on each of the four outcome variables, Wilk's $\Lambda = .31$, $F(4, 57) = 3.99$, $p < .001$, $\eta 2 = .25$. Univariate tests were significant for the memory retrieval test, $F(5, 60) = 14.56$, $p < .001$, $\eta 2 = .55$, near transfer test, $F(5, 60) = 6.84$, $p < .001$, $\eta 2 = .36$, far transfer test, $F(5, 60) = 2.46$, $p = .043$, $\eta 2 = .17$, and motivation, $F(5, 60) = 4.01$, $p = .003$, $\eta 2 = .25$. Tukey HSD tests revealed honestly significant group mean differences at the .05 alpha level indicating that participants who received Embodied Affect with Surrogate Embodiment (EA-SE) scored significantly higher than all other groups on memory retrieval. EA-SE scores were also significantly higher than the control group (NA-NE) on near transfer, far transfer, and motivation. However, no significant differences were found between the Embodied Affect with Surrogate Embodiment (EA-SE) and No Affect with Surrogate Embodiment (NA-SE) groups on motivation scores, implying that embodied affect did not have a significant effect on motivation. Surrogate Embodiment (SE) also scored significantly higher than Imagined Embodiment (IE) on memory retrieval and near transfer, and the Embodied Affect with Imagined Embodiment (EA-IE) group scored significantly higher than the control group on memory retrieval. No other significant differences were found. See Tables 2 to 5 for means and standard deviations.

No statistically significant correlations were found between participants' gender, age, race/ethnicity, first language, country of residence, academic program, prior knowledge of history, attitudes towards history and technology and participants' memory retrieval, near and far transfer, and motivation scores.

	Surrogate Embodiment	Imagined Embodiment	No Embodiment	Marginal Mean
Embodied Affect	25.91 (1.58)	21.91 (2.81)	19.27 (2.83)	22.36
No Affect	22.64 (1.36)	19.55 (2.16)	18.68 (3.00)	20.29
Marginal Mean	24.27	20.73	18.98	21.33

Table 2. Means (and Standard Deviations) for Memory Retrieval

	Surrogate Embodiment	Imagined Embodiment	No Embodiment	Marginal Mean
Embodied Affect	7.36 (2.25)	6.09 (1.45)	4.82 (1.83)	6.09
No Affect	6.00 (1.61)	4.55 (1.13)	3.73 (1.49)	4.76
Marginal Mean	6.68	5.32	4.27	5.42

Table 3. Means (and Standard Deviations) for Near Transfer

	Surrogate Embodiment	Imagined Embodiment	No Embodiment	Marginal Mean
Embodied Affect	5.64 (1.36)	4.64 (1.86)	3.73 (1.95)	4.67
No Affect	4.91 (2.51)	4.18 (1.25)	3.18 (1.89)	4.09
Marginal Mean	5.27	4.41	3.45	4.38

Table 4. Means (and Standard Deviations) for Far Transfer

	Surrogate Embodiment	Imagined Embodiment	No Embodiment	Marginal Mean
Embodied Affect	21.64 (1.91)	20.54 (2.94)	19.54 (2.91)	20.57
No Affect	21.64 (2.83)	20.45 (1.29)	17.54 (2.88)	19.87
Marginal Mean	21.64	20.50	18.54	20.23

Table 5. Means (and Standard Deviations) for Motivation

Discussion

Surrogate groups that were engaged in role-play via their avatar in the rich immersive environment of the MUVE scored higher than the read-only groups on memory retrieval, near and far transfer, and motivation. This suggests that the immersive virtual environment enhanced memory retrieval, transfer, and motivation more than the non-immersive and non-embodied environment. Surrogate Embodiment also scored higher than Imagined Embodiment on memory retrieval and near transfer. Embodied affect further enhanced performance for the surrogate group. This supports previous research findings [4-10].

The results suggest that the amount of embodiment affects learning. The more embodiment learners experienced and the more opportunities learners had to index words and phrases to perceptual symbols via simulations, the better they performed. Therefore, participants scored the highest on memory and transfer when they experienced two types of embodiment (i.e., embodied affect and surrogate embodiment) as compared to when they experienced only one type of embodiment. Imagination also seemed to facilitate memory retrieval more than simply reading. Feedback revealed that participants were creating imaginary worlds [12] while reading, which helped them produce effective mental models [13]. Participants' feedback also revealed that they continued to imagine while reading the text in the transfer tests, and this seemed to improve their performance on the transfer tests.

Embodied learning environments had a significant effect on all dependent variables whereas embodied affect had a significant effect only on memory and near transfer. Motivation seemed to be related to the immersive MUVE environment rather than positive embodied affect. Embodied affect did not have a significant effect on motivation. Although participants reported they felt positive after the embodied affect manipulation, they did not score higher on motivation

than participants who did not get the embodied affect manipulation. One possible reason for this could be the small sample size. Another reason could be the inherent difficulty of the novel historical text participants read. Most participants reported that they found the text difficult to remember since it was culturally unfamiliar, and this perhaps increased cognitive load [14] and contributed to their low motivation scores. The results suggested that there was a need to investigate why positive embodied affect did not have a significant main effect on far transfer and motivation. We also felt that measuring participants' comprehension was needed to gain further understanding of the participants' learning processes. A follow-up study has been conducted with a larger sample size.

The pilot study results provide evidence for embodied learning within MUVEs and this has implications for instruction and learning. Since embodied affect was found to have an effect on memory and transfer and embodied affect further enhanced performance for surrogate groups, it is suggested that embodied affect components be included with MUVEs in classrooms to enhance learning. Classroom instruction could include embodied affect embedded within activities in virtual environments. Participants' feedback also revealed that learners in the MUVE needed more guidance than others, and this suggests that scaffolding is a necessary part of teaching through MUVEs. To provide effective scaffolding, teachers need to be proficient at using MUVEs.

Conclusion

The results indicate that MUVEs have the capability of providing immersive surrogate embodied experiences, and role-playing via avatars in virtual environments can enhance memory, transfer, and motivation as compared to simply reading. Furthermore, the results

suggest that positive embodied affect induced with surrogate embodiment in MUVEs can further enhance memory and near transfer of learning. Further studies are being conducted to investigate the effects of embodied affect within MUVEs on learning and motivation. It is expected that these studies will provide an insight into how immersive virtual environments can be used effectively to facilitate students' memory, comprehension, transfer of learning, and motivation.

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