Effects of Virtual Instructor's Facial Expressions in a 3D Game on Japanese Language Learning

Dixuan Cui* David Whittinghill† Atsushi Fukada‡ Christos Mousas§ Nicoletta Adamo¶

Purdue University, West Lafayette, Indiana 47907, U.S.A.

Abstract

Previous research has shown that student-teacher interaction is very important in motivating students to learn a second language. However, it is unclear whether facial expression, which is one of the most important elements of interaction, affects in-game language learning motivation. The purpose of this study is to investigate whether the facial expressions of the other party, in this case, the in-game virtual instructors, will influence the language learning process for L2 Japanese students. The researchers of this study developed four conditions for a 3D animated Japanese role-playing game. In each condition of the game, only one facial expression was assigned to the virtual characters: neutral, happy, sad, or angry. Eighty-four college students from 200/300 level Japanese courses participated in the study voluntarily. Participants played a version of the game that was assigned to them randomly and then answered a questionnaire concerning language learning. The findings of this research suggested that the virtual characters' in-game facial expressions had no significant effect on participants' language learning. However, significant effects on language learning were found regarding years of learning Japanese and gender. Limitations and future research directions are discussed.

Index Terms: Applied computing—Computers in other domains—Personal computers and PC applications—Computer games; Applied computing—Education—Interactive learning environments

1 Introduction

In recent years, Japanese language learning had become more popular [14, 15]. Various institutes have developed methods for teaching students by using either traditional paper textbooks or online learning software [15, 26]. Nevertheless, it is always important that instructor-student interaction be taken into consideration [16, 30, 32]. Moreover, it is also essential that the educator motivate students throughout the learning process [3, 7].

This study starts with the view that (a) interaction is the key factor to increasing student motivation [23–25], that (b) student motivation is a major objective of education [7, 15], and that (c) a key aspect that enhances human motivation is the facial expressions of the virtual instructor during human-virtual character interaction [5, 31]. Given these considerations, this study attempts to investigate whether the facial expressions of virtual characters can influence the language learning process in an L2 Japanese course. This project builds on prior knowledge about language learning and student motivation, while also expanding on previously published work that investigates the interaction process between foreign language instructors and learners [1, 4, 11], and on studies concerning the effect of a single facial expression on language learning [13, 22, 25].

This research is designed to find evidence demonstrating whether the facial expressions of the other party, in this case, in-game virtual characters, can influence or not the foreign learning motivation of the L2 Japanese students. By providing our participants with the freedom to explore the virtual gaming environment along with instant facial expression feedback based on their action and input [9], this study is attempting to answer the following questions:

- **RQ1:** Do characters' facial expressions in 3D games affect the language learning process of L2 Japanese students?
- **RQ2:** Do participants' years of learning Japanese affect language learning?
- **RQ3:** Are there gender differences in language learning?

This paper is organized in the following manner. Related work is presented in Section 2. The methodology is presented in Section 3, and the obtained results are presented in Section 4. The results are then discussed in Section 5. Finally, the conclusions, limitations, and future research directions are presented in Section 6.

2 Related Work

Notable games have proven to be effective in stimulating learning across several domains. Gebhard et al. [9] has developed a scenario-based game simulation platform for interview training. Monteiro et al. [18] has created a medical training game that can be implemented in a medical education program. Borna and Red [2] have developed a game played in a 3D environment that successfully motivates people to engage in computer science learning. Linehan et al. [17] has created a serious tabletop game to train people in collaborative decision-making behaviors and guide work in performing groups. In all these different studies, these noteworthy games offer a low-cost high-efficiency environment for learning.

According to Lier [16], teaching and learning go hand in hand with interaction. In his study, it was found that students went through a process of shifting between awareness levels, from affordance to critical awareness. Irungu et al. [12] found that learner-teacher nonverbal interaction has significant effects on the academic achievement of Chemistry learners. Siegal [27], a researcher who observed students studying in Hiroshima, proposed that interaction should be weighted based on the needs of the student. Wolfgang's [33] article on nonverbal behavior mentions that previous studies have pointed out a clear relationship between facial emotions and motivational systems. Finally, Mowrer [19], a prominent learning theorist, indicates that emotion affects human behavior in general and helps people learn.

There are a few notable games for Japanese learning as well. The Japanese MMORPG Crystalize, from Cornell University, was designed to help students learn Japanese vocabulary by learning new words within conversations. Students (players) can create a new vocabulary list and then study and review those words. After collecting a certain number of words, students can complete conversation tasks. Another example of such a game for learning Japanese

*e-mail: cui60@purue.edu
†e-mail: dmwhittinghill@purdue.edu
‡e-mail: afukada@purdue.edu
§e-mail: cmousas@purdue.edu
¶e-mail: nadamovi@purdue.edu

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is a language learning game called "Influent."[1] It is a third-person Japanese vocabulary-learning game whose mechanics are simple. By selecting an object in the room, players can learn the word for that item. In the end, there are pop quizzes to test the number of words memorized. This game has received positive feedback, and many Japanese learners use it as a "virtual flashcard" to help them visualize Japanese words when memorizing them. Froschauer et al. [8] has also developed a culture and language learning game, ICURA, to help people learn more about Japanese culture. This is a 3D adventure game and has shown significant learning potential. Moreover, Woo [34] suggests that the increased interaction offered by video games has shown us that students can become highly motivated to learn, which is why such educational games have proven so effective.

Some people also use existing Japanese role-playing games (JRPGs), such as Pokémon,[2] for language learning purposes. The dialogue in these games is at an introductory level, and many beginning Japanese learners use it as a resource. The drawback of this approach is that there is no interaction designed to test the players' comprehension. According to Brian Tomlinson [28], teaching materials such as textbooks have been shifting from simple clichd dialogues to social culture-based content. It is believed that more realistic content will increase student interest in learning.

Motivation has been proven to have a great effect on student success. Woo [34] has verified the fact that motivation is proportional to cognitive and skill-related performance. Obrentz's [23] study on Chemistry students has shown a significant impact of learning motivation on their final grades, self-efficacy, and control over anxiety. Even more, many studies have demonstrated the key factors that affect motivation. According to Ebata [7], self-confidence, the experience of success and satisfaction, good relationships between teachers and students, and a friendly environment are the key motivation factors. Ebata has mentioned a quote from Atsuta, which holds that "At the heart of all learning is a person's belief in his or her ability to accomplish the task." The instructors' attitude and enthusiasm are also key in motivating students. Cheng and Dornyei [3] have developed a list of important factors that affect student motivation. On the top of that list, a teacher's interest in the subject matter, along with how much he/she tries, has a strong impact on student motivation in L2 language learning. Furthermore, Karaoglu [15] mentions that creating situations in which students feel a sense of accomplishment can ensure students' positive attitudes and encourage self-evaluation. Schultheiss et al. [25] performed a test on a large sample of students regarding the motivational changes they experienced while undergoing various emotions. The highly motivated students preferred the low-dominance emotion, and the poorly motivated students preferred the high-dominance emotion. Hudlicka and Broekens [11] have asserted in their modeling tutorial that emotions on virtual characters affect gamers' cognition through a person's neuromodulator transmitters.

3 Materials and Methods

The methodology and implementation details of this study are presented in this section.

3.1 Participants

For this between-group study, the participants were recruited through in-class announcements and e-mails. The participant group was comprised of 84 individuals aged between 18 and 35 years of age from a 200/300-level Japanese course. There were 19 male ($M = 20.68$, $SD = 1.62$) and 65 female ($M = 21.54$, $SD = 1.81$) students. All students participated on a volunteer basis. All participants have had previous experienced with video games and have studied at least one semester of Japanese. Participants provided written consent before participating in our study, as dictated by the Institutional Review Board of our university.

[1] https://store.steampowered.com/app/274980/Influent/

[2] https://www.pokemon.com/us/

3.2 The 3D JRPG Daigaku Life

We have developed a 3D animated Japanese role-playing game called Daigaku Life. The story of this game was created based on a personal study-abroad experience at Nanzan University, in Nagoya, Japan. In this scenario, the main character, called Takeru, wants to make a documentary film about his study-abroad life in Japan. To do so, he attempts to find interviewees. By interviewing his classmates and teachers, he finally obtains enough clips to make the video (shown in Figure 1). The game environment is composed of one large outdoor environment and three in-door environments (two hallways and one office). Several character models and animations were downloaded from Mixamo. Additional animations and the blend shapes of the facial expressions were created in Autodesk Maya by a professional animator. All 3D models (virtual environment and virtual characters) were imported into the Unreal Engine. The gameplay and mechanics were scripted using the Blueprints functionality of the Unreal Engine. We developed four versions for the game. Each version assigns one of the examined facial expressions to the virtual characters participating in the game: neutral, happy, sad, or angry (shown in Figure 2). Except for the facial expressions that were randomly assigned to the virtual character, the remainder of the game and its mechanics were the same for all experimental conditions.

Figure 1: Screenshots of the gameplay, with the main character exploring various locations.

Players are required to control the main character in order to finish tasks, make conversation with other characters, and keep moving on to the next levels. All operations are the same in all the four versions (facial expression conditions). Indicators are designed to instruct players regarding how to continue to the next levels. Players must select the correct responses of the other party, based on their social identity and level, to move on to the next levels (shown in Figure 3). If they make the wrong choice, the facial expression of the virtual character will change from neutral to angry, sad, or happy or simply stay the same, depending on the experimental condition the participant was assigned. Finally, a hint box will pop up that says "use appropriate language."

3.3 Measurements

In this study, a questionnaire was developed based on the Tour-Tillery and Fishbach's [29] motivation questionnaire and the Dornyei [6] second language learning questionnaire. Toure-Tillery and Fishbach [29] have summarized a set of measures for motivation, which focus on accessibility, evaluation, experience, perception, speed, performance, and choices [29]. In our study, the questionnaire divides motivation into three core components: language learning motivation, time spent, and performance. Both, time spent (speed) and

Figure 2: The four facial expressions of the five characters that the user interacted with during the gameplay. From left to right: angry, happy, neutral, sad.

Figure 3: In-game conversation examples. Players must select the correct response. If they answer incorrectly, the scripted facial expression will be displayed. Players will need to press "continue" to proceed.

performance are referenced from Toure-Tillery [29]. The questionnaire includes two questions about language learning motivation, one question about time spent, and another question about performance. The participants answered all the questions using a rating scale from 1 to 7, with 1 indicating "strongly disagree" and 7 indicating "strongly agree."

3.4 Procedure

To begin, the participants were randomly divided into four groups, with 21 participants in each group. The experiment was conducted in the computer lab of our department. Once the participants arrived, the experimenter briefed all participants about the procedure of the study. Before starting the experiment, the participants were asked to sign the consent form and complete a demographics questionnaire. The consent form was handed to them. The demographics questionnaire was computer- based. Then, the experimenter helped the participants set up the game and informed them about the basic operations of the gameplay.

Next, each participant played one of the four versions of the game. The participants began to read through the dialogs and select their responses. No one was allowed to communicate with other participants during the entire process. After the gameplay, the participants were asked to fill out a computer-based post-game questionnaire. Once finished, participants were thanked for their participation, and then, they were informed of the purpose of the study. The participants were also allowed to ask any questions upon completion of the study. The total duration of the experiment was less than 30 minutes.

4 Results

All results obtained from our study are summarized in this section. All the analyses were performed using IBM SPSS V. 23.0 [21] statistical analysis software. A one-way analysis of variance (ANOVA) was used to analyze the obtained data while using the four facial expressions (game levels) as independent variables and the learning motivation components as dependent variables. The normality assumption of the measurements was evaluated graphically using Q-Q plots of the residuals [10]. The Q-Q plots indicated that the obtained data fulfilled the normality assumption. The individual differences were assessed using a post-hoc Bonferroni correction if the ANOVA was significant. Moreover, we also conducted ANOVAs to explore the effects of years of learning Japanese on learning motivation (four groups: less than one year, 1-2 years, 2-3 years, and more than three years), while using the four facial expressions (game levels) as independent variables and the learning motivation components as dependent variables. We also conducted an independent sample t-test to explore the influence of gender on the learning motivation components. For all statistical tests, $p < .05$ was deemed as statistically significant.

4.1 Effects of Facial Expression

In order to answer the research questions, the data on the factor *facial expressions* were collected. Unfortunately, there were no significant effects on the part of facial expression on participants' **performance** ($F(3,80) = .91$, $p = .44$), **time spent** ($F(3,80) = 1.905$, $p = .135$), and **learning motivation** ($F(3,80) = .97$, $p = .411$).

4.2 Effect of Years of Learning Japanese

Considering the fact participants may have different levels of Japanese learning time, which can be a potential factor affecting learning motivation, the data for the factor *years of learning Japanese* were collected during the study. The statistical analysis showed that the effect of *years of learning Japanese* was significant on **time spent** ($F(3,80) = 4.472$, $p = .004$). Post-hoc comparisons showed that the 1-2-year group ($M = 3.91$, $SD = 1.35$) spent significantly less time than the less-than-one-year group ($M = 5.07$, $SD = 1.34$) and more time than the more-than-three-years group ($M = 5.33$, $SD = .82$). No significant difference was found between the 1-2-years group and the 2-3-years group ($M = 3.61$, $SD = .92$). No significant effect on the part of *years of learning Japanese* was found on **learning motivation** ($F(3,80) = .863$, $p = .464$) and **performance** ($F(3,80) = 1.508$, $p = .219$).

4.3 Gender Differences

Regarding language learning, *gender* may have an effect on learning motivation. For this reason, gender differences were also explored. The independent sample t-test showed a significant difference between the male ($M = 4.20$, $SD = 1.31$) and female ($M = 2.20$, $SD = .84$) participants in terms of **learning motivation**; $t(82) = -2.674$, $p < .01$. However, no significant gender effects

were found on **performance** [$t(82) = -.879$, $p = .382$] and **time spent** [$t(82) = -1.684$, $p = .096$].

5 Discussion

The purpose of this study was to examine whether game-character facial expressions would influence the learning motivation of L2 Japanese students. The researchers of this study developed a 3D animated Japanese role-playing game. Participants were asked to play the game and complete a post-questionnaire. Findings were drawn based on self-reported ratings.

In terms of the individual components of **learning motivation**, we were not able to find significant results across the examined experimental conditions (the facial expressions of the virtual characters). These results partially answer **RQ1**, regarding whether facial expressions affect learning motivation. The results suggest there are no facial emotion-related differences in learning motivation. This is in line with Nikitin and Freund [22]. In their study about the relationship between age, facial expression, and avoidance motivation, they demonstrated that although motivation is related to age, it is not significantly related to individual facial expressions. Perhaps, further studies including other factors such as interaction, are needed to prove their findings. Thus, at this point, it is reasonable to conclude that facial expressions have no significant effect on learning motivation.

For *years of learning Japanese*, only the **time spent** component was significant, which partially answer **RQ2**, concerning whether participants' years of learning Japanese would affect any of the examined variables. For **time spent**, the participants who had studied Japanese for 1-2 years completed the gameplay significantly faster than those who had studied Japanese for less than one year or more than three years. A similar result was found by Oxford et al. [24]. Following their research, previous language learning experience affected instrumental and general motivation at a nearly significant level. Moreover, Tillery and Fishbach's [30] research suggests that motivation can manifest itself in terms of the amount of time it takes an individual to act in the pursuit of a goal and that **time spent** can be applied to various aspects of behavior to measure the strength of motivation. According to Tillery and Fishbach [30], in a goal-focused task, the less time participants spend, the more motivated they are. Therefore, it can be concluded that the participants who completed the gameplay significantly more quickly had stronger motivation than the others.

We were also able to find a *gender* difference for the language **learning motivation** variable, which answer **RQ3**, regarding whether participants' gender affects their motivation to learn a foreign language. Based on our results, female participants were more motivated by the games than male participants. A similar outcome was found by Oxford et al. [24], indicating that females showed significantly more motivation based on the integrative and personal aspect in language learning than males, as well as that males needed more encouragement to recognize the value of learning a foreign language. Nicovich et al. [20] also found that regarding computer-mediated communications, women engage in watching more commonly than in doing, causing more observations. Thus, it can be concluded that because the game story in the 3D JRPG "Daigaku Life" was simply a media story, the engagement of our female group made them perceive the virtual characters' appearance in the game more realistically than the male group.

6 Conclusions, Limitations, and Future Work

The main finding of this research demonstrated that virtual characters' facial expressions in-game had no significant effect on participants' language **learning motivation**. The second finding was that the factor **years of learning Japanese** had a significant effect on the variable **time spent**. This means that the participants' experience of language learning affected the amount of time they spent completing the game. The last finding of this study was that the **gender** of the participants had a significant influence on language **learning motivation**. The data analysis results suggest that females were more motivated than males in terms of language learning.

Three limitations should be mentioned at this point. First, other in-game elements, such as in-game environment, game story, character animation, and game interactivity, could have influenced the results of the study, resulting in biased data. Second, the research did not involve the use of an eye-tracking device to record the attention of all the 84 participants, due to the limited number of eye-tracking devices available. This means that the effect of facial expressions may not have been measured precisely, because the participants may not have paid much attention to the in-game characters' facial expressions. Third, the vast majority of the sample consisted of female participants. Thus, considering Nicovich et al.'s [20] research, which has indicated that males are more interested in interactive media, our sample size might have affected our results of the other examined variables.

It is recommended that this type of research be applied to other language areas to validate its findings and applicability. To develop stronger evidence, additional studies in different subject domains and settings must be conducted. As an extension, based on the significant findings of this study, more research should be performed by the developers of learning games on the various aspects that are involved in order to maximize the language learning effect. In addition, a simplified game design for use in research is required. Elements potentially influencing the experimental outcome should be considered in advance and eliminated during the development process. These include a complex game environment, background music, and complex game controls. Lastly, an eye-tracking device should be used when asking people to interact with a gaming environment. This will ensure the precision of the data collected on participants' attention allocation. All these are aspects we are planning to explore in our future work.

References

[1] A. L. Baylor. The design of motivational agents and avatars. *Educational Technology Research and Development*, 59(2):291–300, 2011.

[2] K. Borna and H. M. Rad. Serious games in computer science learning goals. In *Digital Games Research Conference: Trends, Technologies, and Applications*, pp. 161–166, 2018.

[3] H.-F. Cheng and Z. Dörnyei. The use of motivational strategies in language instruction: The case of efl teaching in taiwan. *International Journal of Innovation in Language Learning and Teaching*, 1(1):153–174, 2007.

[4] K. Cheng and P. A. Cairns. Behaviour, realism and immersion in games. In *CHI Extended Abstracts on Human Factors in Computing Systems*, pp. 1272–1275, 2005.

[5] Z. Dörnyei. Individual differences: Interplay of learner characteristics and learning environment. *Language learning*, 59:230–248, 2009.

[6] Z. Dörnyei and T. Taguchi. *Questionnaires in second language research: Construction, administration, and processing*. Routledge, 2009.

[7] M. Ebata. Motivation factors in language learning. the internet tesl journal, 14 (4), 2008.

[8] J. Froschauer, I. Seidel, M. Gärtner, H. Berger, and D. Merkl. Design and evaluation of a serious game for immersive cultural training. In *International conference on virtual systems and multimedia*, pp. 253–260, 2010.

[9] P. Gebhard, T. Schneeberger, E. André, T. Baur, I. Damian, G. Mehlmann, C. König, and M. Langer. Serious games for training social skills in job interviews. *IEEE Transactions on Games*, 11(4):340–351, 2018.

[10] A. Ghasemi and S. Zahediasl. Normality tests for statistical analysis: a guide for non-statisticians. *International journal of endocrinology and metabolism*, 10(2):486, 2012.

[11] E. Hudlicka and J. Broekens. Foundations for modelling emotions in game characters: Modelling emotion effects on cognition. In *Interna-*

tional Conference on Affective Computing and Intelligent Interaction and Workshops, pp. 1–6, 2009.

[12] M. N. Irungu, G. Nyagah, and M. Mugambi. Learner-teacher non-verbal interaction effect on academic achievement of learners in chemistry. *African Educational Research Journal*, 7(2):88–96, 2019.

[13] N. Iwashita. The effect of learner proficiency on interactional moves and modified output in nonnative–nonnative interaction in japanese as a foreign language. *System*, 29(2):267–287, 2001.

[14] D. M. Johnson. Natural language learning by design: A classroom experiment in social interaction and second language acquisition. *Tesol Quarterly*, 17(1):55–68, 1983.

[15] S. Karaoglu. Motivating language learners to succeed. *Compleat Links*, 5(2), 2008.

[16] L. V. Lier. The relationship between consciousness, interaction and language learning. *Language awareness*, 7(2-3):128–145, 1998.

[17] C. Linehan, S. Lawson, and M. Doughty. Tabletop prototyping of serious games for'soft skills' training. In *Conference in Games and Virtual Worlds for Serious Applications*, pp. 182–185, 2009.

[18] M. Monteiro, A. Corredoura, M. Candeias, P. Morais, and J. Diniz. Central hospital—master of resuscitation: An immersive learning approach. In *IEEE International Conference on Serious Games and Applications for Health (SeGAH)*, pp. 1–4, 2011.

[19] O. Mowrer. Two-factor learning theory: Versions one and two. *Learning theory and behavior*, 1960.

[20] S. G. Nicovich, G. W. Boller, and T. B. Cornwell. Experienced presence within computer-mediated communications: Initial explorations on the effects of gender with respect to empathy and immersion. *Journal of Computer-Mediated Communication*, 10(2), 2005.

[21] N. H. Nie, D. H. Bent, and C. H. Hull. *SPSS: Statistical package for the social sciences*, vol. 227. McGraw-Hill New York, 1975.

[22] J. Nikitin and A. M. Freund. Age and motivation predict gaze behavior for facial expressions. *Psychology and Aging*, 26(3):695, 2011.

[23] S. B. Obrentz. *Predictors of science success: The impact of motivation and learning strategies on college chemistry performance*. PhD thesis, Georgia State University, 2012.

[24] R. Oxford, Y. Park-Oh, S. It, and M. Sumrall. Japanese by satellite: Effects of motivation, language learning styles and strategies, gender, course level, and previous language learning experience on japanese language achievement. *Foreign language annals*, 26(3):359–371, 1993.

[25] O. C. Schultheiss, J. S. Pang, C. M. Torges, M. M. Wirth, and W. Treynor. Perceived facial expressions of emotion as motivational incentives: evidence from a differential implicit learning paradigm. *Emotion*, 5(1):41, 2005.

[26] J. K. Shin. Literacy instruction for young efl learners: A balanced approach. *National Geographic Learning*, pp. 1–9, 2000.

[27] M. Siegal. The role of learner subjectivity in second language sociolinguistic competency: Western women learning japanese. *Applied linguistics*, 17(3):356–382, 1996.

[28] B. Tomlinson. Materials development for language learning and teaching. *Language teaching*, 45(2):143, 2012.

[29] M. Touré-Tillery and A. Fishbach. How to measure motivation: A guide for the experimental social psychologist. *Social and Personality Psychology Compass*, 8(7):328–341, 2014.

[30] L. Verga and S. A. Kotz. How relevant is social interaction in second language learning? *Frontiers in human neuroscience*, 7:550, 2013.

[31] M. Volante, S. V. Babu, H. Chaturvedi, N. Newsome, E. Ebrahimi, T. Roy, S. B. Daily, and T. Fasolino. Effects of virtual human appearance fidelity on emotion contagion in affective inter-personal simulations. *IEEE transactions on visualization and computer graphics*, 22(4):1326–1335, 2016.

[32] Y. Watanabe and M. Swain. Effects of proficiency differences and patterns of pair interaction on second language learning: Collaborative dialogue between adult esl learners. *Language teaching research*, 11(2):121–142, 2007.

[33] A. Wolfgang. *Nonverbal behavior: Applications and cultural implications*. Academic Press, 2013.

[34] J.-C. Woo. Digital game-based learning supports student motivation, cognitive success, and performance outcomes. *Journal of Educational Technology & Society*, 17(3):291–307, 2014.