EDUCATIONAL PSYCHOLOGY | RESEARCH ARTICLE

The effect of synchronous and asynchronous computer-mediated communication (CMC) on learners’ pronunciation achievement

Majid Zeinali Nejad¹, Mohammad Golshan² and Amin Naeimi³

Abstract: Within the field of second language acquisition, pronunciation has received relatively little attention. This lack of research can also be seen in the general lack of systematic pedagogical materials for pronunciation training, effectively reinforcing the “marginalized” nature of pronunciation in the second language classroom (Lee, Plonsky & Saito, 2019). Accordingly, the current study investigated the use of synchronous/asynchronous computer-mediated communication as a method of L2 pronunciation instruction for the phonemic and lexical features of pronunciation. Broadly, the current study examined the effectiveness of face-to-face, synchronous, and asynchronous voice computer-mediated communication on EFL learners’ pronunciation achievement. In so doing, the study utilized an experimental design with 15 participants in the control group and 30 participants in two experimental groups. There were two types of tests in this study: lexical stress test, and phonemic discrimination test. The results showed the positive effect of CMC-oriented instruction compared with F-F instruction on EFL learners’ pronunciation development; however, not a significant difference was found between the two CMC instructional modes. The Syn group, on the other hand, tended to vary their

ABOUT THE AUTHOR

Majid Zeinali Nejad is a Ph.D. candidate in TEFL at Islamic Azad University, Maybod branch. His research interests are language assessment, educational linguistics, and language skills. Mohammad Golshan is an assistant professor of TEFL at Islamic Azad University, Maybod branch. His research interests include task-based language teaching, focus on form, corrective feedback, and second language acquisition. Amin Naeimi is an assistant professor of TEFL at Islamic Azad University, Yazd branch. His research interests include second language acquisition and pragmatics.

PUBLIC INTEREST STATEMENT

Learning a second language (L2) means much more than memorizing a new set of vocabulary and a few syntactic and grammatical rules. Some scholars have tested, confirmed, and emphasized the importance of pronunciation, reporting that effective communication is impossible when nonnative speakers’ pronunciation falls below a certain threshold level, even when their vocabulary and grammar are perfect (Levis, 2018). The current study investigated the use of computer-mediated communication as a method of L2 pronunciation instruction for the phonemic and lexical features of pronunciation. There were two types of tests in this study: lexical stress test, and phonemic discrimination test. The results showed the positive effect of CMC-oriented instruction compared with F-F instruction on EFL learners’ pronunciation development; however, not a significant difference was found between the two CMC (synchronous & asynchronous) instructional modes. The Syn group, on the other hand, tended to vary their pronunciation achievements more than the other groups.
pronunciation achievements more than the other groups. Indeed, technology holds great potential for pronunciation training, particularly in terms of maximizing opportunities for practice and exposure to oral language.

Subjects: Arts & Humanities; Language & Literature; Language Teaching & Learning

Keywords: L2 Pronunciation; Lexical stress; Phonemic minimal pairs; Synchronous/asynchronous computer-mediated communication

1. Introduction

Little attention is given to pronunciation in the field of second language acquisition, especially in terms of more dominant areas of morphology and syntax (Deng et al., 2009; Gilbert, 2008). Notwithstanding, on featuring the significance of pronunciation in language acquisition, research has shown that pronunciation has clear effects on communicating meaning efficiently, adequately (i.e., comprehensibility) and productively (i.e., intelligibility), where a certain accent is held in a second language (L2) and may drive undesirable negative assessments of L2 speakers by local speakers of the target language (Lee et al., 2019). Learning a second language (L2) means much more than merely memorizing a new set of vocabulary, a few syntactic and grammatical rules; hence, some researchers have tested, confirmed, and stressed the significance of pronunciation, reporting that effective communication is impossible when nonnative speakers’ pronunciation falls below a specific threshold level, even when their vocabulary and grammar are perfect (Derwing & Munro, 2015; Levis, 2018).

This lack of research can also be seen in the general lack of systematic pedagogical materials for pronunciation training, which may lead to effectively an increase in the “marginalized” nature of pronunciation in the second language classroom (Baker, 2013). Despite this general lack of attention to pronunciation, students show enthusiasm to learn more about pronunciation and hold the belief that it is an integral component of L2 learning (Levis & Grant, 2003). Consequently, a growing bulk of research has begun to investigate new methods of instruction for L2 pronunciation out of which one method of particular interest has been highlighted: a combination of pronunciation instruction with the use of speech analysis technology. Fortunately, technology supports teachers’ and learners’ understanding and acquisition of new pronunciation patterns (Wallace & Lima, 2018). Our emphasis on pronunciation in this paper is based on two factors. First, pronunciation is an underexplored and neglected area in EFL contexts (Breitkreutz et al., 2001; Neri et al., 2006). Second, research on the effect of interaction using SVCMC with a focus on pronunciation improvement does not exist now to the best of our knowledge.

Research on the second language (L2) acquisition has shown that most language learners have difficulties in mastering L2 sound patterns with the ability of a native speaker (Nosratinia & Zaker, 2014; Nushi et al., 2019). An important limiting factor in acquiring the pronunciation of an L2 is the interference from the native language (L1). Several theories have been advanced to explain L1–L2 interference in speech processing and to predict its consequences. In many Iranian English classrooms, teachers do not pay enough attention to pronunciation instruction because it includes a lot of challenges concerning their limited pronunciation knowledge or skill. Further, some teachers lack enough time in their classes to teach pronunciation (Nosratinia & Zaker, 2014). In effect, in Iran, English is regarded as a foreign language and learners do not use it out of their classes and because of the large number of students in every class teachers are not able to control the classes and check their learners’ pronunciation (Nushi et al., 2019). Consequently, the current study addresses the use of a synchronous/asynchronous computer-mediated communication paradigm with rich and authentic content for the instruction of L2 pronunciation in the EFL context of Iran. Research in this area is particularly important to help us understand how to best promote and ensure learners benefit from tasks in L2 speech learning. The current study is a promising research avenue that will hopefully contribute to creating more effective methods for language pronunciation teaching and learning.
2. Review of the literature

2.1. Digital technology use in second language instruction
The technology era in which we live presents brilliant chances for education systems. It offers opportunities for teaching, learning, and pedagogy (Battro & Fischer, 2012; Kim, 2020). The digital term refers to technologies such as multimedia environments and devices which can present information in real-time and at high speed (Gallardo-Echenique et al., 2016). The rapid growth in the application of digital technologies, especially the computerized mediated instruction devices such as the Internet and computers, has a significant impact on education, society, and many aspects of daily life (Blake, 2017; Jelfs & Richardson, 2012; McGinn & Parrish, 2002; Pennington & Rogerson-Revell, 2019). Advances in technology and the digital world led to the emergence of virtual worlds to foster asynchronous (offline) and synchronous (online) communications between the users. Of the many network technologies which are employed in CALL, immersive virtual environments seem to hold great potential as learning tools (Albakhshi & Mohammadi, 2016). The effect of the integration of technology in general and computer in the educational settings is clear and most teachers are fully aware of technology tools. Such an application of technology modernized the process of teaching and learning. It was both a technological and educational revolution (Son, 2008). Abrams (2008) mentioned computer-mediated instruction helps learners negotiate and interact with their peers actively to develop their communicative competence. She pointed out, “computer-mediated learner-to-learner interaction provides unique opportunities for L2 learners for the active control of the topic selection and management and provides rich opportunities for learners to understand and adapt to diverse interactional patterns through collaboration among the interactants” (p. 1). Zeng (2017) reported that CMC provides favorable conditions for the emergence of the target language features.

2.2. Asynchronous communication
Asynchronous communication is the dominant form of educational computer-mediated communication (CMC) (Johnson & Aragon, 2003). It occurs in delayed time without simultaneous access to educational outcomes (Johnson, 2006). It helps the teacher to link together related notes, allowing students to follow multiple simultaneously occurring patterns and discussions (Hewitt, 2005). Some studies report the advantages of asynchronous CMC compared to synchronous CMC and face-to-face courses, including time-independent access, opportunities for heightened levels of peer interaction, avoidance of undesirable classroom behavior, and support for multiple learning styles (Morse, 2003). Asynchronous communication supports and follows the constructivist-based education, where the teacher is a collaborator (Cavanaugh, 2009; Gold, 2001). Meyer (2003) mentioned several time-based advantages of threaded discussions, including increased time-on-task, extra time for reflection, and sufficient opportunities for everyone to contribute to the discussion. Some studies argue that asynchronous communication provides in-depth and thoughtful discussions (Branon & Essex, 2001; Tu & Corry, 2003). However, when characterizing levels of cognitive presence, there is some evidence (Rourke & Kanuka, 2009) that most student reports fall in the lowest levels of cognition. Rovai (2007) highlighted the importance of having an active teacher to form cohesive learning communities, encourage students, and serve as supporters and facilitators. Besides, asynchronous courses permit the teaching role to be spread across individuals in the form of student moderators or facilitators. In contrast to face-to-face courses, students in asynchronous courses motivate a more central teaching presence role (Heckman & Annabi, 2005), particularly when those students are assigned to moderate weekly discussions (Rourke & Anderson, 2002). Rourke and Anderson (2002) asserted that addressing the constituents of teaching presence can be discouraging for a single teacher and that student moderation can distribute and balance such duties.

2.3. Synchronous communication
Synchronous communication involves immediate communication between teachers and students, usually in the form of text chat (Johnson, 2006). Some studies suggested that social presence is more
obvious in synchronous chat than in asynchronous discussion. For instance, Schwier and Balbar (2002) compared asynchronous discussion to synchronous chat in a graduate education course. Schwier and Balbar (2002) reported that synchronous communication works well for content that “inspires natural debate or passion”, but that asynchronous communication may be preferred for content that is dry or requires reflection since synchronous communication may not provide the time or concentration required to engage deep ideas. Regarding the research on the nature of interaction in the SCMC mode, synchronous communication is believed to allow learners to communicate with some discourse functions and negotiation sequences like the FTF medium and to facilitate the learners’ monitoring of language through increased participation and interaction. Johnson (2008) analyzed learning achievements in an educational psychology course where students used synchronous chat or asynchronous discussion to discuss four different case studies. There were no significant differences in student learning across the two modes, a surprising finding considering the studies cited above (Nippard & Murphy, 2008; Schwier & Balbar, 2002). Further evidence that synchronous chat can be useful for content learning can be found in the study by Kuyath (2008). In addition to comparing the social presence of chat and synchronous discussion, Kuyath compared the two modes of content learning. Kuyath found that chat students performed significantly better on the assignments than email students. Similarly, Stein et al. (2007) argued that, with the appropriate teaching and social presence, students can arrive at a shared understanding in a synchronous environment. However, Moradi and Farvardin (2019) reported no significant differences between the frequency of negotiations in face to face and synchronous modes. But the results were controversial regarding the quality of negotiations because the SCMC mode requires L2 learners to type their messages, teachers can make benefit of these data by providing CF to learners after the chat to enhance their L2 learning. Each mode, with appropriate facilitation, can support different forms of critical thinking, and, for this reason, the use of both modes is of great interest to researchers. Most relevant studies in this area do not consider the combined effects of both modes in the same learning environment. For example, some studies compared courses or discussions using synchronous tools to those using asynchronous tools (Davidson-Shivers et al., 2001; Dudding & Drulia, 2009); others compare single-mode courses to courses using at least two modes (Hrastinski, 2006; Rockinson-Szapkiw, 2009). In these latter studies, the focus is not on the independent contributions of each mode, but on the improvement obtained when adding synchronous tools to asynchronous courses or face-to-face courses (Cox et al., 2004). Hines and Pearl (2004) clarified the needs for productive synchronous communication while mentioning that asynchronous communication is also important. Other researchers performed case studies or arguments for the significance of synchronous communication (Blankson & KyelianBlankDickey, 2003; Ene & Upton, 2018; Pineda Hoyos, 2018; Shotsberger, 2000; Son, 2008). Further, there are some challenges with synchronous communication, such as the confusion caused by not being able to explicitly find links between messages (Holmer et al., 2009) or the technology needed to support the use of synchronous moderators (Schwarz & Asterhan, 2011). However, few studies suggest the combined benefits of both modes, generally with encouraging results. For instance, Ligorio (2001) studied the use of synchronous chat and asynchronous discussion in a multi-school online collaboration. They discussed that students’ interactive use of both modes improved over time and that each mode performed a different and complementary goal. The present study is designed to investigate the simultaneous offering of both modes of CMC to the students.

2.4. Technology integrated pronunciation instruction
The growing enthusiasm toward technologies to facilitate language learning (Computer-Assisted Language Learning, or CALL) has grown rapidly in recent decades, so there is a large demand for CALL products, particularly in Asia. The field of Computer-Assisted Pronunciation Training, or CAPT—including for both language teaching/learning and speech therapy—is also on a swift development. Both have major impacts on education and language learning/teaching, so researching their effects is important. In addition, both are turning large business, which in some cases means that sales are running ahead of educational value. There is obvious availability of technology-based teaching/learning tasks, such as the motivational effect created by the novelty or “wow” factor, the availability of multimodal resources comprising audio, print, and video, and the enhanced mobility of being able to study anytime anywhere. CAPT (Computer-Assisted Pronunciation Training) can also provide
endless opportunities for repetition and imitation, instantaneous responses, as well as exposure to a wide range of target language speech; it can also facilitate individualized, self-paced learning. One of the main advantages of CAPT technology is the opportunity to provide automated feedback; the use of speech technologies can be particularly advantageous for the feedback it reflects on pronunciation. Moreover, a number of the technologies used for teaching and learning pronunciation have certain applications to do research and testing (Pennington & Rogerson-Revell, 2019).

Technology in many ways has been used to enhance receptive knowledge resulting in improving productive knowledge, or the initiation of the ability to produce these new pronunciation patterns. Technology helps learners to identify distinctions between their pronunciation and the target language pronunciation in focused speech and extended discourse. Listening to recordings of their speech allows ELLs to analyze their pronunciation in greater depth and consequently identification of the chance they can take to speak in real-time which potentially leads to improved self-monitoring. Once they can produce a pronunciation of the target language, there are ample opportunities for learners to practice, whether it is through audio or video recordings, imitation, and analysis, or speaking with others using computer software and apps (Wallace & Lima, 2018).

Within the relatively limited research on methods for pronunciation instruction, the use of technology, and specifically visualization, has begun to receive considerable support. Generally, speech analysis technology that provides a visual representation and realization of speech features (e.g., intonation, intensity, formant transitions, etc.) has been considered for its potentiality as a methodology for pronunciation instruction. Pedagogical or training implementation of visual representation has taken different forms, including providing a visual model of NS pronunciation (e.g., De Bot, 1980), providing audio-visual modeling of NS productions (e.g., De Bot, 1983), and (roughly) simultaneous representations of L2 participant-produced speech compared with NS models (e.g., Olson, 2014b). In each case, the main goal is for L2 learners to be presented with visual representations of NS productions, compare their productions to those of the NS, and through noticing differences, improve pronunciation of the target language feature.

Motivated by the relative lack of focus on pronunciation in investigations of FTF, SCMC, and ASCMC learner-learner and learners-teacher interactions, the present study is guided by the following research questions:

1. To what extent does face to face interaction affect EFL learners’ pronunciation features (phonemic minimal pair and word stress)?
2. To what extent does synchronous voice computer-mediated communication affect EFL learners’ pronunciation features (phonemic minimal pair and word stress)?
3. To what extent does asynchronous voice computer-mediated communication affect EFL learners’ pronunciation features (phonemic minimal pair and word stress)?
4. Comparing FTF, SCMC, and ASCMC, which one is more effective in fostering EFL learners’ pronunciation features (phonemic minimal pair and word stress)?

3. Methodology

3.1. Participants
To test the hypotheses underpinning the research model, forty-five female adults, all native Persian speakers with normal hearing abilities, participated in this study. To ensure that the participants of the study were at almost the same level of English proficiency, the researchers applied the Longman Placement Test (LPT) at the first session of the project. The participants in this study (N = 45) ranged in age from 18 to 35 with an average age of 22 and had begun to study the English language at an average age of 10. All participants had at least minimal exposure to oral SCMC modalities. Ethical approval for this study was obtained from the university administrators. It was explained to the students that they could participate in the course even if they did
not agree to be part of the research. During the project, students’ participation was completely voluntarily, and they received no remuneration. It had been made clear that the students could withdraw from the study at any stage with no consequences, that pseudonyms would be used to ensure confidentiality and anonymity, and that the data would not be shared with anyone including the university administrators. They also understood and agreed that the researchers could record the interviews and use the results of the data collection only for research purposes.

3.2. Instruments
To capture and collect the required data before and after the project, the researcher utilized a quantitative research method applying 3 tests as the instruments of this study. A description of each instrument is presented here. They were collected at the beginning and end of the study. The course instructor reserved the first day of class for the pre-test and the last day of class for the post-test.

3.2.1. Longman placement test (LPT)
To choose almost homogenous participants in general terms of the English language LPT, a criterion-referenced measure developed by Pearson Longman ELT (2006), was used. This test system contains 100 written multiple questions and places students as follows:

- 00–20 Below Elementary
- 21–35 Elementary
- 36–60 Pre-intermediate
- 61–85 Intermediate
- 86–100 Upper-Intermediate

3.2.2. Lexical stress test
The participants were asked to complete the pronunciation achievement test, lexical stress part (Appendix A), designed by Higher Education Language & Presentation Support (HELPs) the University of Technology, Sydney (2016) containing two parts of comprehension and production. The production parts were recorded and thereafter judged either correct or incorrect by three blind evaluators, whose opinions on the participants’ pronunciation skills were concurrent. The inter-rater reliability was 0.89 showing a strong agreement between the three raters.

3.2.3. The minimal pair test: phonemic discrimination
The participants were asked to distinguish distinctive phonemic contrasts (Appendix B). All items included 3 words: one different, two of the same [a] book/cook/book, and b) beg/peg/beg. The participants answered to a form with the numbers a) 1 2 3, and b) 1 2 3 corresponding to the items on the tape. They had to circle the number representing the word they heard as different, in case a) it is sound number 2 (cook), and in case of b) it is sound number 2 (peg). The whole test was recorded on tape by a native speaker of English provided by Higher Education Language & Presentation Support (HELPs) the University of Technology, Sydney (2016).

3.2.4. Study tasks
To follow the same tasks in all groups, the participants in the control and two experimental groups completed the three following tasks in face-to-face, synchronous, and asynchronous modes of instruction:

**Picture Differences Task**: In this task, participants had to spot the difference between two similar pictures. Participants had to share information about their respective pictures to complete the task. No linguistic information was provided, and learners had to agree on a specified set of differences.
Consensus Task: This task required participants to come to an agreement about the information provided to them, based on a set of criteria.

Conversation Task: To elicit more naturalistic interaction between participants, a conversation task was used in which participants asked about their partners’ favorite things, in addition to describing their own. All three tasks were two-way information gap tasks to maximize negotiation; however, several other task conditions were varied.

3.3. Procedure
A quasi-experimental research design that included three intact classes was used. The study was undertaken at a university located in Kerman, Iran. One class acted as FTF group (n = 15), and 30 participants acted as experimental groups according to the computer-mediated communication they received: SCMC Group (n = 15), and ASCMC Group (n = 15). The use of pretests facilitated the exploration of the size and direction of selection bias. Before each test started, the participants were given instructions in Persian. To ensure that misunderstandings did not occur and to provide proof that the instructions had been thoroughly understood, two examples of each test were given to each of the participants. Additionally, the participants were told that mistakes would be negligible, and they could proceed with the test even though they were not sure of the correct answers.

The learners were enrolled in a semester course (45 contact hours over 15 weeks) of English conversation course for EFL learners. The main objective of the course was the improvement of the students’ proficiency in oral skills, and pronunciation, listening, and speaking skills were treated in class. Participants were invited to participate in an English interaction study outside of class time. Learners were randomly assigned to one of the three instructional modalities, resulting in 15 FTF (face to face student-student and teacher-student interaction inside the classroom), 15 SCMC (online student-student and teacher-student interaction in the university English language lab), and 15 ASCMC (offline computer-mediated communication with delayed teacher-students interaction on WhatsApp). Each session lasted a total of 50 to 60 min. Audio recordings of the interactions were saved for subsequent analysis. The participants completed the same tasks in the control and two experimental groups: a picture differences task, a consensus task, and a conversation task. All three tasks allowed learners to use their linguistic resources were related to real-world activities and had non-linguistic outcomes (Ellis, 2003). A post-test was conducted to measure the degree of improvement in each learner’s English pronunciation achievement at the end of the implementation period.

4. Results
The current study adopted a quantitative methodology to address the research questions. Data analysis was dependent on the research method and data collected. In order to examine the effect of FTF, SCMC, & ASCMC on EFL learners’ phonemic discrimination and lexical stress, paired sample t-test, One-way ANOVA Test, and post hoc test were run.

Observation of the diversification of control group phonemic discrimination in the pre-test and post-test showed that their phonemic discrimination was not significantly different in the pre-test and post-test. The effect size was \( ES = 0.61, r = 0.29 \). Meanwhile, the variation of ASCMC experimental group phonemic discrimination in the pre-test and post-test stated that the mean of phonemic discrimination in the experimental group (ASCMC) was significantly different in pre-test and post-test. It declares that the mean of phonemic discrimination in the experimental group (ASCMC) in the post-test was significantly more than the pre-test. Next on watching the variation of SCMC experimental group phonemic discrimination in the pre-test and post-test, observation shows that the mean of phonemic discrimination in the experimental group (SCMC) was significantly different in the pre-test and post-test. It means that the mean of phonemic discrimination in the experimental group (SCMC) in the post-test was significantly more than the pre-test (Table 1).
On the variation of the experimental groups (SCMC & ASCMC) and control group phonemic discrimination in the pre-test, the result did not show any significant difference between the mean scores for the pre-test. (Table 2).

After checking the variation of the experimental groups (SCMC & ASCMC) and control group phonemic discrimination in the post-test, the results strongly confirmed a significant difference between the mean scores in post-test (Table 3).

Phonemic discrimination in the experimental group (ASCMC) and the control group was not different. And phonemic discrimination in two experimental groups (SCMC &ASCNC) was not significantly different. But there was a significant difference between the experimental group (SCMC) and the control group (Table 4).

The result of checking variation of the control group lexical stress in pre-test and post-test shows that the mean of lexical stress in the control group was different in pre-test and post-test. The effect size was ES = 0.93, r = 0.42. Next on observing the variation of ASCMC experimental group lexical stress in the pre-test and post-test, the mean of lexical stress in the experimental group (ASCMC) was significantly different in the pre-test and post-test. It means that the mean of lexical stress in the experimental group (ASCMC) in the post-test was significantly more than the pre-test. Additionally, the effect size was ES = 2.58, r = 0.79. Later, checking the variation of SCMC experimental group lexical stress in pre-test and post-test, the mean of lexical stress in the experimental group (SCMC) was significantly different in the pre-test and post-test. It means that the mean of

| Table 1. Paired sample T-test of phonemic minimal pair discrimination |
|---------------------------------------------------------------|
| **Time** | N  | Mean | St. Deviation | T-Test | Df  | P-Value |
|------------|----|------|---------------|--------|-----|---------|
| (FTFG) pre-test post-test | 15 | 14.27 | 1.65 | −7.79 | 14 | 0.0005 |
| (ASCMCG) pre-test post-test | 15 | 14.17 | 1.54 | −16.84 | 14 | 0.0005 |
| (SCMC) pre-test post-test | 15 | 14.20 | 1.68 | −22.98 | 14 | 0.0005 |

| Table 2. ANOVA test of phonemic discrimination in pre-test |
|---------------------------------------------------------------|
| **Model** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P-Value** |
|------------|---------------------|-------|-----------------|------|-------------|
| Between Groups | 0.08 | 2 | 0.04 | 0.02 | 0.98 |
| Within Groups | 110.67 | 42 | 2.64 |
| Total | 110.74 | 44 |

| Table 3. ANOVA test of phonemic discrimination in post-test |
|---------------------------------------------------------------|
| **Model** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P-Value** |
|------------|---------------------|-------|-----------------|------|-------------|
| Between Groups | 20.93 | 2 | 10.47 | 4.12 | 0.02 |
| Within Groups | 106.77 | 42 | 2.54 |
| Total | 127.70 | 44 |
Lexical stress in the experimental group (SCMC) in post-test was significantly more than the pre-test. Additionally, the effect size was ES = 6.46, r = 0.96 (Table 5).

After that in studying the variation of the experimental groups (SCMC & ASCMC), and control group lexical stress in the pre-test, the result showed that the lexical stress of the experimental groups (SCMC & ASCMC) and control group was not significantly different in the pre-test (Table 6).

Finally, on observing the variation of the experimental groups (SCMC & ASCMC), and control group lexical stress in post-test, the result shows that the lexical stress of the experimental groups (SCMC & ASCMC) and control group was significantly different in the post-test (Table 7).

Lexical stress in the experimental group (ASCMC) and the control group was different. And lexical stress in the experimental group confirmed a significant difference between the control and the experimental group (SCMC) in the post-test. There was a significant difference between the experimental groups (SCMC &ASCMC), too (Table 8).

5. Discussion
As mentioned before, the pronunciation skills of Iranian EFL university students were investigated concerning phonemic minimal pairs and word stress in this study. All the groups showed

| Table 4. Post Hoc Test of phonemic discrimination in post-test |
|-----------------|-------|--------------|----------------|-----------|
| Group           | N    | Mean         | Mean Difference | P-Value   |
| ASCMC           | 15   | 15.97        | 0.74            | 0.4       |
| FTF             | 15   | 15.23        |                 |           |
| SCMC            | 15   | 16.90        | 1.67            | 0.02      |
| FTF             | 15   | 15.23        |                 |           |
| SCMC            | 15   | 16.90        | 0.93            | 0.2       |
| ASCMC           | 15   | 15.97        |                 |           |

| Table 5. Paired Sample T-test of lexical stress |
|-----------------------------------|-------|--------------|---------------|-----------|
| Time                                     | N    | Mean         | Standard Deviation | T-Test  | df    | P-Value |
| (FTFG) pre-test post-test             | 15   | 72.47 80.53  | 10.47 6.88     | −3.63   | 14    | 0.003   |
| (ASCMC) pre-test post-test           | 15   | 72.60 96.13  | 10.74 9.03     | −24.20  | 14    | 0.0005  |
| (SCMC) pre-test post-test            | 15   | 75.73 122.60 | 9.07 5.45      | −33.80  | 14    | 0.0005  |

| Table 6. ANOVA test of lexical stress in pre-test |
|------------------|--------|-------------|------------|--------|--------|
| Model            | Sum of Squares | Df | Mean Square | F     | P-Value |
| Between Groups   | 102.53   | 2 | 51.27       | 0.50  | 0.6    |
| Within Groups    | 4300.27  | 42| 102.39      |       |        |
| Total            | 4402.80  | 44|             |       |        |
improvement in pronunciation performance (phonemic minimal pair discrimination and word stress) from pretest to posttest. The statistical analysis answered the research questions as follows:

The first research question was: RQ1. To what extent does face to face interaction affect EFL learners' pronunciation features (phonemic minimal pair and word stress)?

Regarding the first research question, FTF group showed some improvements in pronunciation performance (phonemic minimal pair discrimination and word stress) from pretest to posttest. Aligned with the results of the current study, Ellis (2003) reported that FTF instruction is effective in pronunciation development in some contexts and for some phonological features. In this study, the FTF group showed some improvements revealing the fact that FTF instruction in settings with no technological tools can make some changes. In a similar line, Moradi and Farvardin (2019) reported no significant differences between the frequency of negotiations in face to face and synchronous modes. However, the results were controversial regarding the quality of negotiations. because the SCMC mode requires L2 learners to type their messages, teachers can make benefit of these data by providing CF to learners after the chat to enhance their L2 learning.

The second question was: RQ2. To what extent does synchronous voice computer-mediated communication affect EFL learners' pronunciation features (phonemic minimal pair and word stress)?

SCMC group showed great improvements in pronunciation performance (phonemic minimal pair discrimination and word stress) from pretest to posttest. The findings of this study are in line with Alibakhshi and Mohammadi (2016) and Coyle and Prieto (2017) that during online tasks, learners are likely to achieve more accurate results. According to Abrams (2008), engagement in meaning-focused tasks through CMC helps learners raise awareness of L2 features, understand “the interactional micro-level patterns of a speech culture”, and try to “adapt their language to act in such speech communities” (p. 16). Authentic tasks involving the learners in interaction and feedback help them notice and repair their own and others’ phonetic features (Fraser, 1999; Morley, 1991). SCMC provides authentic tasks, intensive interaction, and feedback on individual language production by engaging students in interaction challenges with the teacher and their peers and thus may contribute to the phonetic improvement. The outcomes of technology-based teaching and learning tasks are the high levels of motivation, the availability of multimodal resources, and the enhanced mobility of study (Pennington & Rogerson-Revell, 2019).

### Table 7. Kruskal-Wallis test of lexical stress in post-test

| Group | N  | Mean Rank | Chi-Square | Df  | P-Value |
|-------|----|-----------|------------|-----|---------|
| FTF   | 15 | 8.73      | 37.19      | 2   | 0.000   |
| ASCMC | 15 | 22.33     |            |     |         |
| SCMC  | 15 | 37.93     |            |     |         |

### Table 8. Post Hoc Test Tamhane’s T2 of lexical stress

| Group | N  | Mean  | Mean Difference | P-Value |
|-------|----|-------|-----------------|---------|
| ASCMC | 15 | 98.13 | 17.60           | 0.000   |
| FTF   | 15 | 80.53 |                 |         |
| SCMC  | 15 | 122.60| 24.47           | 0.000   |
| ASCMC | 15 | 98.13 |                 |         |
| SCMC  | 15 | 122.60| 42.07           | 0.000   |
| FTF   | 15 | 80.53 |                 |         |
Besides the results of the current study, evidence that synchronous mode of instruction can be useful for content learning can be found in the study by Kuyath (2008) that chat students performed significantly better on the assignments than email students. Regarding the research on the nature of interaction in the SCMC mode, synchronous communication is believed to allow learners communicate with some discourse functions and negotiation sequences like the FTF medium and to facilitate the learners’ monitoring of language through increased participation and interaction (Rouhshad et al., 2016).

The third question was: RQ3. To what extent does asynchronous voice computer-mediated communication affect EFL learners’ pronunciation features (phonemic minimal pair and word stress)?

Regarding the asynchronous instruction, aligned with the results of the current study, Morse (2003) reported that asynchronous instruction is effective in pronunciation development in some contexts and for some phonological features. Some studies (Branon & Essex, 2001; Morse, 2003; Tu & Corry, 2003) in line with our study report the advantages of asynchronous CMC, including time-independent access, opportunities for heightened levels of peer interaction, avoidance of undesirable classroom behavior, and support for multiple learning styles. The results of our study confirming Zeng (2017) showed that CMC provides favorable conditions for the emergence of the target language features. According to Baron (2000), synchronous CMC constructs a process-oriented debate to exchange their ideas and monitor their partners’ reactions. Through this way, they can figure out the best solution to the given situation. On the other hand, Baron (2000) argued that the asynchronous CMC triggers a product-oriented output that deliberates messages before they are produced. Since language production in asynchronous contexts is not subject to time and place constraints and is not interfered with by factors prevalent in traditional face-to-face classes, as Hurd (2006) reports, learners generate the language at the same time, discuss their understanding of the language, and revise their responses.

The fourth question was: RQ4. Comparing FTF, SCMC, and ASCMC, which one is more effective in fostering EFL learners’ pronunciation features (phonemic minimal pair and word stress)?

ANOVA results showed that the difference among groups was not significant for phonemic minimal pair discrimination and word stress on the pretest, so the distribution was regular in all the groups. However, the mean improvement was significant in all the groups on the posttest (FTF, SCMC & ASCMC). There were no significant differences in student learning across the two modes confirming studies by Murphy and Nippard (2007) and Schwier and Balbar (2002). The greatest development occurred in the SCMC group followed by the ASCMC group and the FTF group. So, SCMC and ASCMC groups showed to be more effective for pronunciation improvement. This suggests that performing the tasks in the synchronous learning activities makes the language points more salient to the students (Ene & Upton, 2018). However, some studies report the advantages of asynchronous CMC compared to synchronous CMC and face-to-face courses, including time-independent access, opportunities for heightened levels of peer interaction, avoidance of undesirable classroom behavior, and support for multiple learning styles (Morse, 2003). And some others suggest the integration of synchronous and asynchronous modes of CMC (Elola & Oskoz, 2016) to maximize opportunities for the students to notice and understand language features.

In sum, this research demonstrated the positive impacts of synchronous and asynchronous types of instructional CMC on the production of pronunciation among L2 learners. It is hoped that teachers, educators, and course designers would use the CMC mode of instruction to provide rich pedagogical opportunities for learners. The decision on which mode to use CMC (synchronous or asynchronous) however depends on contextual factors. In selecting either asynchronous or synchronous CMC modes as mentioned by Fitzpatrick and Donnelly (2010), issues like human needs, desires, expectations, and institutional and pedagogical goals play a fundamental role. In brief, the technology implemented in this study presented brilliant chances for education systems. It offers opportunities for English language teaching, learning, and pedagogy in the field of L2 pronunciation.
6. Conclusion
The present study investigated the impact of the synchronous and asynchronous CMC modes on EFL learners’ pronunciation development compared with the F-F mode of instruction. The findings revealed the positive effect of CMC-oriented instruction compared to F-F instruction on the acquisition of English pronunciation by EFL learners; however, there was no significant difference between the two CMC instructional modes. The Syn group, on the other hand, tended to vary their pronunciation achievements more than the other groups. From the data, it can be concluded that SCMC is beneficial for pronunciation because it provides enough breakdowns in communication through which students can notice the gaps in their current phonetic interlanguage and thus produce phonetically modified output. The findings of this study confirmed Pineda Hoyos (2018) report of the effective communicative nature of CMC learning activities. In brief, technology supports teachers’ and learners’ understanding and acquisition of new pronunciation patterns, therefore, there is a crystal-clear benefit for the inclusion of CMC pronunciation instruction in the L2 classrooms. Considering the findings, EFL teachers are recommended to provide their language learners with opportunities to benefit from different forms of technology in their instructional programs; moreover, they can enrich their instruction by making use of online and offline communications. As Elola and Oskoz (2016, 2017) note, the field of L2 teaching should pay attention to digitally mediated instruction as an important affordance of 21st century literacy and pedagogy. Although this study successfully investigated the demanded topic, there were some limitations through the path that must be considered before assessing its contributions. This study took place in one site with a small sample size (n = 45) and therefore, only reflects English language learners in Iran. The small sample size could be considered to lack statistical representation. As the study participants may be influenced by the context of the study, we recommend further studies be conducted using CMC in other subject areas. Studies should also be conducted in different cultures amongst students attending institutions and schools as well as different residential areas. Because of the significant differences between males and females, the impact of gender merits further investigation. The results of the present study are limited to female participants due to boys’ withdrawal from the study so the results cannot be generalized to both sexes. Concerning the quantitative nature of the study design, qualitative studies can enrich the findings, too.

Funding
The authors received no direct funding for this research.

Author details
Majid Zeinali Nejad1
E-mail: mzeinalinejad1926@yahoo.com
Mohammad Golshan2
E-mail: Mohammadgolshann@gmail.com
Amin Naeimi2
E-mail: naeimiamin@gmail.com

1 Ph.D. Candidate in TEL, Maybod Branch, Islamic Azad University, Maybod, Iran.
2 English Department, Maybod Branch, Islamic Azad University, Maybod, Iran.
3 English Department, Yazd Branch, Islamic Azad University, Yazd, Iran.

Citation information
Cite this article as: The effect of synchronous and asynchronous computer-mediated communication (CMC) on learners’ pronunciation achievement, Majid Zeinali Nejad, Mohammad Golshan & Amin Naeimi, Cogent Psychology (2021), 8: 1872908.

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Appendix A
Word Stress

Listen to the words then tick the answer with the correct stress.

1. really o really o really

2. report o report o report

3. remember o remember o remember o remember

4. yesterday o yesterday o yesterday o yesterday

5. exam o exam o exam

6. revision o revision o revision o revision

7. difficult o difficult o difficult o difficult

8. opinion o opinion o opinion o opinion

9. possible o possible o possible o possible
10. business  o b u s i n e s s  o b u s i n e s s  o b u s i n e s s

Listen to each pair of words. When you add the suffix, does the stress stay on the same syllable or move to a different syllable? Select “same” or “different”. And show the difference.

1. revise      revision
2. permit      permission
3. artist      artistic
4. history     historical
5. public      publicity
6. celebrate   celebration
7. tropic      tropical
8. economy     economics
9. inform      information
10. essence    essential
11. minor      minority
12. possible   possibility
13. practice   practical
14. decide     decision
15. office     official
16. technique  technical
17. operate    operation
18. science    scientific
19. secure     security
20. describe   description

Read the following words

1) b a s k e t b a l l
2) w a t e r m e l o n
3) c o m p u t e r
4) E n g l i s h
5) m i l k
6) c h o c o l a t e
7) c a k e
8) s o c c e r
9) u n i v e r s i t y
10) f i r e f i g h t e r
11) c a m e r a
12) s t a t i o n
13) telephone
14) DVD
15) elevator
16) blackboard
17) chalk
18) backpack
19) world
20) Japanese

Appendix B
Minimal Pairs

B/P
bee/pea/bee
bin/pin/pin
beg/peg/beg
beep/peep/peep
bay/pay/bay
beach/peach/beach
bark/park/bark
big/pig/big
bees/peas/bees
bath/path/path
bug/pug/bug
bye/pie/bye

B/T
bow/tow/bow
boy/toy/toy
bee/tea/bee
buy/tie/buy
boo/two/two
bed/ted/bed
bin/tin/bin
bug/tub/bug
book/took/book
back/tack/back
bun/ton/ton
buck/tuck/buck
B/D
bow/dough/bow
buy/die/buy
boo/do/do
buck/duck/duck
bay/day/bay
bait/date/bait
bark/dark/bark
