

THE EFFECTS OF TEXT-BASED SCMC ON SLA: A META ANALYSIS

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As various means of computer mediated communication (CMC) have been incorporated within language classrooms over the past two decades, it has become important to critically understand whether, to which extent, and under what contextual factors, a particular type of CMC is more effective than other modes of communication. This study examined the magnitude of the effect of text-based synchronous computer-mediated communication (SCMC) on second language acquisition (SLA). By searching the studies published between 1990 and 2012, this meta-analysis explored 10 experimental and quasi-experimental journal articles and doctoral dissertations and reports their overall effect on SLA, and the contextual factors that influence the between-study variation. A small but positive overall effect ($m = .33$) indicates that text-based SCMC could make a larger difference on SLA than other means of communication. Findings further suggested that intermediate learners may benefit more from SCMC tasks if they are grouped into pairs or small groups and participate in SCMC interactions on a weekly basis. In terms of suggestions for future research, authors should provide more description about the SCMC task in order to confirm or disconfirm the factors that are associated with effectiveness of second language (L2) learning in technology-mediated language learning contexts.

Key Words: Text-Based Synchronous Computer-Mediated Communication (SCMC); Second Language Acquisition (SLA); Quantitative Meta-Analysis

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INTRODUCTION

Over the past two decades, synchronous computer-mediated communication (SCMC), defined in this article as synchronous written chat (excluding audio and voice chats), has been commonly applied to enhance various aspects of foreign or second language learning. As a technology and communication tool, SCMC has been said to have a strong potential for encouraging the negotiation of meaning in interaction. This is because of SCMC's resemblance to spoken communication and the textual features of discourse, which allow learners with more time to attend to language output (Blake, 2009; Kern, 1995; Satar & Ozdener, 2008; Smith, 2005; Sykes, 2005). Benefits of applying SCMC to second language (L2) classrooms have been reported including more equitable student participation (e.g., Kern, 1995), more learner language output (e.g., Sequeira, 2009; Sullivan & Pratt, 1996), better quality of linguistic production (e.g., Chun, 1994; Warschauer, 1996a), more student motivation and interest (Warschauer, 1996b), and reduced communication anxiety (Satar & Ozdener, 2008). SCMC provides students with an authentic way to learn the target language through communicative use, reduces students' anxiety of talking face-to-face, and gives students more opportunities to express their ideas than oral communication does. As a result of these qualities, it has attracted much attention from researchers in the field of computer assisted language learning (CALL).

Chapelle (2009), in a recent review article concerning general CALL studies and SLA theories, indicated

that SCMC is effective for second language learning in several language domains: grammatical development (e.g., Pelletieri, 2000), oral proficiency (e.g., Payne & Whitney, 2002), lexical development (e.g., de la Fuente, 2003; Smith, 2004), and negotiation of meaning in communication (e.g., Blake, 2000). However, there are limitations of SCMC which may lead to L2 learning outcomes that are not as positive as the previously described ones. For instance, Liu and Sadler (2003), in a study on peer reviews for English as a Second Language (ESL) writing, found the SCMC mode in their electronic environment—with more than two student members chatting at a time—yielded chaotic flows of online messages with frequent problematic turn-taking or chaotic multiple comments which impeded comprehension or revision. Hirotani, in his 2009 study of Japanese learners, found that the quality of learners' language output was not easy to improve through text-based SCMC. He hypothesized that this was because learners' pace of typing and reading messages might be inhibited by unfamiliar words during chatting, due to their limited linguistic knowledge.

The effects of SCMC on L2 development have been often examined from an SLA interactionist perspective. Compared to face-to-face interaction, the written nature of text-based chat programs have been argued to facilitate more form-focused linguistic modifications during interaction, as learners have more time to plan and reflect upon what is typed. This has the result of conveying error-free and precise messages (Pelletieri, 2000). Such noted potential has motivated research efforts in operationalizing central constructs in the interactionist framework such as *noticing*, *focus on form*, *repair*, *uptake*, and *pushed output* in SCMC contexts. Recent findings, however, seem to reveal that the negotiation of meaning in SCMC environments is qualitatively different from the negotiation of meaning in face-to-face interaction. Smith (2008), for example, found that learners produced more linguistically complex output when repairs were self-initiated. Fernández-García and Martínez-Arbelaiz (2003) and Lee (2002) both reported that negotiation of meaning took place in SCMC interaction, even if there were no communication breakdowns.

Findings from some interactionist SCMC studies suggest that key notions of the SLA interactionist framework need to be expanded when applied to SCMC interaction. This is because data collection methods in traditional classrooms and SCMC contexts are fundamentally different. For example, self repair has been investigated by Smith and Sauro (2009) using learner deletion and the editing of text-chats. Similarly, Yilmaz and Yuksel (2011) used nonverbal behaviors such as cursor and keyboard movements as indicators of noticing and awareness. Within the SCMC context, L2 learning processes have been recorded through data collection tools and methods such as screen-capture software—recording chatscripts, learner on-screen behaviors (Smith, 2008), or interlocutor images (Yamada & Akahori, 2009). However, as Smith and Sauro (2009) have noted, how productive learning outcomes can be documented through these tools is still unexplored. Interoperating chat interaction with varied SCMC data collection methods can help us understand familiar constructs of SLA such as self-repair or learner uptake with a new light (Smith, 2005, 2008).

In addition to the difference of data collection methods, recognizing the unique nature of SCMC interaction also means interpreting SCMC interaction in terms of its task characteristics, conditions, processes, and contextual variables when examining its effects on L2 development. Ortega (1997) has noted the importance of carefully describing task features when analyzing computer-assisted interactions, so that task conditions and contextual variables conducive to language development in computer mediated interactions can be meaningfully compared to face-to-face tasks.

Because a growing body of SCMC studies has been conducted over the past two decades under different contexts yielding mixed findings, a synthesis of the research is needed to help our field examine the impact of SCMC use on L2 learning. One such type of research synthesis is meta-analysis. Glass (1976), has defined meta-analysis as a statistical analysis of a collection of primary research data, calling it “the analysis of analyses” (p. 3). Typical meta-analyses begin with a literature search of primary sources, empirical studies that meet selection criteria. This sample pool is then coded, analyzed, and interpreted

based upon a set of pre-defined features. Then, researchers estimate an effect size, this being defined as the magnitude of the effect of one variable on the other variable (Cooper & Hedges, 1994). Through the calculation of the effect sizes, the findings from different primary empirical studies can be converted into comparable values. Meta-analysis has developed into a science providing SLA researchers replicable methods that summarize cumulative knowledge within a domain (Norris & Ortega, 2000, 2006; Plonsky, 2011). In one of the first meta-analyses concerning SLA, Norris and Ortega (2000) examined 49 studies published between 1980 and 1998 and verified that focused L2 instruction was indeed effective (effect size $d = .96$).

Meta-Analyses and CALL Research

In CALL areas, several meta-analyses have recently been published, addressing various aspects of using technologies to enhance language learning and teaching. One of the earliest efforts to consider CALL effectiveness is Zhao's analysis (2003) of nine studies from a sample of 389 journal articles published between 1997 and 2001 in English. He found a large effect size ($d = 1.12$) for CALL and claimed that the use of technology was generally a more effective teaching method than traditional ones. More recently, Taylor (2006) analyzed 18 studies that compared the efficiency of traditional first language (L1) glosses with that of electronic L1 glosses in L2 reading, finding that providing learners with electronic glosses (e-glosses) had a large effect on understanding more text ($d = 1.09$) than those learners with paper-based glossing aids. Abraham (2008) surveyed 11 experimental studies in order to compare the effects of L2 learners' access to computer-mediated glosses (L1; or, L1 and L2 together) to those without such access. The results showed that computer-mediated glosses had an overall medium effect ($m = .73$) on their reading comprehension and a large positive effect ($m = 1.40$) on incidental vocabulary learning. To connect the results from Taylor (2006) and Abraham (2008), Taylor's 2009 meta-analysis research with 32 studies revealed that the overall effect sizes of e-glossing studies ($d = .51$) were larger than those of traditional glossing studies. Recently, Yun (2011) considered 10 primary studies with 35 weighted mean effect sizes (overall, $d = .37$), examining specific variables such as modes of glosses, test type, and language proficiency. Yun found that multiple hypertext glosses were more likely to yield an influence on beginning learners' L2 vocabulary acquisition.

In a recent review article, Sauro (2011) conducted a qualitative synthesis that examined the overall research trends, methods, and findings of 97 SCMC journal articles over the past 20 years (1990–2010). Following Canale and Swain's (1980) conceptual framework for communicative competence, Sauro classified the primary research studies under four types of competences: grammatical, sociolinguistic, discourse, and strategic. Of the 97 studies, grammatical competence was most investigated, with 48 out of the 97 studies exploring this competence through SCMC. However, only half of the 48 grammatical competence articles directly addressed the issue of how SCMC use could effectively impact linguistic development. Most of the other SCMC studies touched upon L2 learners or learning processes through linguistic or technological strategies for negotiating communication, the changes of discourse functions, and the use of speech acts plus participant roles, or language socialization, among others. Sauro suggests that "SCMC is a productive context for examining L2 processes and outcomes in a manner that incorporates and builds upon research in face-to-face contexts while also beginning to explore the technologically influenced tools and strategies unique to computer-mediated contexts" (2011, p. 383). While these different issues in the reviewed SCMC research for SLA were discussed, the effectiveness of SCMC in different skill areas of communicative competence was not addressed in a quantitative way with the calculation of effect sizes.

To our knowledge, none of the meta-analyses that have been conducted specifically address the use of SCMC on L2 learning outcomes. To fill this gap, we conducted a meta-analytic review of the effectiveness of SCMC on SLA by collecting experimental and quasi-experimental SCMC studies and calculating and comparing effect sizes across studies. In this meta-analysis, we extended the scope of previous analyses to include doctoral dissertations database searches from the years 1990 to 2012. Five

contextual factors were examined that were quantifiable and hypothesized to have an impact on the overall effectiveness. This was done in order to show the between-study variation in terms of participants' L2 proficiency level, target language, the language learning conditions (ESL or EFL), the duration of SCMC treatment, and grouping methods as designed in the SCMC activities. It is hoped that with a close quantitative examination, future research directions for applying SCMC for L2 learning can be more precisely indicated.

Accordingly, the two research questions we ask are:

1. What is the overall effect of text-based SCMC on SLA?
2. What are the contextual factors that influence the between-study variation on effects of text-based SCMC on SLA?

METHODS

The present meta-analysis was conducted in four steps: (a) literature search; (b) selection of eligible studies; (c) coding of study reports; and (d) calculation of effect size.

Literature Search

Following the recommendation made by In'nami and Koizumi (2010) from their study examining the quality of databases that had been used for meta-analyses in applied linguistics, this current literature search was conducted using five databases: Educational Resources Information Center (ERIC), Linguistic and Language Behavior Abstracts (LLBA), Social Science Citation Index (SSCI), PsycINFO, and ProQuest Digital Dissertation Full Text (PQDT). We believe that these databases provide an adequate coverage of representative journals in applied linguistics and are frequently used by meta-analysts. During the search process, two main search terms—*computer-mediated communication* (CMC) and *synchronous computer-mediated communication* (SCMC)—were combined with the following keywords: *second language acquisition* (SLA), *second language learning*, *chat*, *grammatical*, *lexical*, *oral*, *reading*, *writing*, *speaking*, *vocabulary*, *speech act*, *interaction hypothesis*, *negotiation*, *focus on form*, *sociocultural theory*, and *task*.

Besides searching in these databases, 10 journals that have published SCMC studies were also manually checked, including *CALICO Journal*, *Canadian Modern Language Review*, *Computer Assisted Language Learning*, *Language Learning*, *Language Learning & Technology*, *The Modern Language Journal*, *ReCALL*, *Studies in Second Language Acquisition*, *System*, and *TESOL Quarterly*. Moreover, all the reference sections of review articles and the retrieved primary studies were also examined, and the full-text doctoral dissertations searched from PQDT were included in the present meta-analysis as well.

Inclusion and Exclusion Criteria of Eligible Studies

In order to select eligible studies for this quantitative meta-analysis, inclusion criteria were built and each selected primary study had to meet the following six screening criteria:

1. The study had a quasi-experimental or experimental design. Only the studies that examined the effect of second language learning interventions via text-based SCMC through a quasi-experimental or an experimental design could provide the needed data for the present quantitative meta-analysis.
2. The study included at least one experimental group and one control/ comparison group.¹ The effect sizes in the present study were calculated based on the group difference. The experimental groups were involved in text-based SCMC interventions in which learners were doing activities through text-chat.² The control/comparison groups were involved in the traditional instruction or computer-mediated activities other than text-based SCMC.

3. The dependent variable was a measurement of certain target language features (e.g., grammatical judgment tests, oral proficiency measures). Only the studies that provided quantifiable data of the measures were included.
4. The study was published between 1990 and 2012, because most discussions of using text-based SCMC on second language acquisition have occurred after 1990, and the current literature search was conducted in 2012.
5. The study should be reported in English, as translation and linguistic homogeneity were considered difficulties that would interfere with the analysis.
6. The publication type of the study should be a journal article or a doctoral dissertation. Since other types of unpublished manuscripts were not easy to retrieve, only the articles and doctoral dissertations searched from the five databases were included.

Coding Study Reports

As a result of the first search for relevant literature, 145 articles were found. In the second stage, these articles were filtered through the six screening criteria described above, leaving 17 studies. In the third stage, six studies lacked the necessary statistical information such as mean and standard deviation to calculate the effect size (e.g., Fiori, 2005; Sykes, 2005), and thus were excluded. Finally, of this pool of 11 studies, Sauro (2009), though studying three groups using online-chat, did not have a control group, and was therefore excluded as well. In the end, 10 studies remained as the body of the meta-analysis (as identified with an asterisk in the reference section).

The 10 studies we include here were independently read and coded by one of the researchers and by an MA-TEFL graduate student, using a list of 24 study features from a coding manual (see [Appendix A](#)). For the feature of research design, the control groups of the studies were categorized into comparison groups and true control groups. The comparison group refers to the group that was involved in any types of CMC activities other than text-chat or face-to-face communication activities during treatments. One example of a comparison group is an asynchronous computer-mediated communication (ACMC) group who sent email or gave responses on forums. In contrast, the true control group refers to the group that received traditional face-to-face instructions without any interaction or communication activities. For instance, some true control groups only took pre-tests and post-tests for comparison, and some only received traditional grammar instructions. Because some studies had more than one experimental group, these groups were regarded as different samples for the calculation of effect size.

The training session for coding involved coding two journal articles randomly chosen out of the 10 and discussing the codings with a faculty member in applied linguistics. The final coding had an agreement ratio of .89 (the number of mutually coded items divided by the total items of the 10 articles on the coding scheme). Disagreements were discussed and resolved by the two coders after finishing all the coding (see the summary of coding results in [Appendix B](#)).

Effect Size Calculation

To demonstrate the effectiveness of text-based SCMC on second language acquisition, effect sizes were calculated by estimating Cohen's d (1977). To compute Cohen's d , means and standard deviations, commonly provided by researchers in experimental reports, were obtained to complete the quantitative meta-analysis. By contrasting the immediate post-test data of each experimental group and each control/comparison group, d was computed. For studies using more than one learning outcome measure, the effect size was calculated by averaging the d values across several dependent variables that targeted at the same language feature (Norris & Ortega, 2000). Then, Cohen's d was used to calculate unbiased standardized mean difference effect sizes (Hedges' g), or weighted mean effect sizes based on the sample size of each primary study (Lipsey & Wilson, 2001; Yun, 2011).

The confidence interval is the range in which the effect size might be located. Following Cohen's (1977) explanation of effect size d values, the effect size around .8 or above is considered a large effect, around .5 a medium effect, and around .2 a small effect. In order to determine the statistical significance of the mean effect sizes, 95% confidence intervals were calculated for each weighted mean effect size (Lipsey & Wilson, 2001; Norris & Ortega, 2000, pp. 449–450). Confidence intervals that contain the value zero indicate that the mean effect sizes are not statistically significant (Norris & Ortega, 2000); values not containing the value zero are interpreted as statistically significant. The narrower the confidence interval is, the more trustworthy the obtained effect is. Cochran's homogeneity of variance tests (the Q -test, cited in Lipsey & Wilson, 2001) were conducted to determine whether the distribution of the effect sizes was due to the sampling error alone. If the Q value exceeds the critical value for a chi-square with $k-1$ degrees of freedom (where k represents the group members for comparison), the hypothesis that the variance is caused by only sampling error is rejected (Lipsey & Wilson, 2001), and the variation is thought to be caused by the variables observed from the primary studies. In the present study, the Q values were calculated by using the Comprehensive Meta-Analysis software.

RESULTS

We first present a brief review of the 10 chosen studies. Then we provide the results that help us answer the initial research question, which considers the overall effectiveness of text-based SCMC on second language acquisition. Finally, we address five contextual factors which may influence the between-study variation on effects of text-based SCMC on SLA.

As described, based on the identified 24 study features, we coded 10 articles (their detailed results are shown in [Appendix B](#)). With the publication dates ranging from 2002 to 2011, the 10 studies included two unpublished dissertations and eight journal articles. Sample sizes ranged from 24 to 96, with the majority being adult learners (a total of 562). Five studies were conducted with English L1 learners, and five were conducted with mixed L1 learners. Four target language outcomes were examined: oral performance (Abrams, 2003; Blake, 2000; Hirotani, 2009; Kost, 2004; Payne & Whitney, 2002; Satar & Ozdener, 2008; Sequeira, 2009), grammatical competence (Abrams, 2003; Hirotani, 2009; Loewen & Erlam, 2006; Sequeira, 2009), lexical development (Abrams, 2003; de la Fuente, 2003; Hirotani, 2009; Yilmaz & Yuksel, 2011), and writing performance (Kost, 2004). Seven studies examined learners' oral skill, followed by four on grammatical competence, and four others on lexical development (see [Table 1](#)).

A summary of the major study characteristics of the 10 reports is presented in [Table 1](#). The target languages identified in the 10 primary studies were English, German, Japanese, Spanish, and Turkish. Different from Sauro's review article (2011), oral performance was examined in seven studies as a target language feature, ranked as the most important, followed by lexical and grammatical aspects. Because four of the 10 studies examined more than one target language feature, comparing effect sizes concerning particular target language outcomes across the 10 studies would be an unfair calculation. As to L2 learning contexts, seven studies were conducted in an FL setting, two studies were conducted in ESL contexts, and one, in an EFL context.

Since learners' target language proficiency levels were not reported consistently in the primary studies, following Norris and Ortega (2000) we used the amount of target language instruction that the learners received before the investigation as a proxy for L2 proficiency levels. Accordingly, *low-level* refers to learners with 0–2 semesters of L2 instruction, while *mid-level* refers to learners with 3–4 semesters of instruction. *Mix-level* refers to a group including both low- and mid-level learners. Among the 10 primary studies, four studies involved mid-level learners; four studies, low-level learners; and two studies, mixed level learners. No study involved advanced learners.

In terms of the treatment duration, four studies administered the instructional activities for more than 10 weeks (defined as *long*), two studies involved treatments between one and ten weeks in length (*mid*), and

Table 1. Summary of Major Characteristics of the 10 Studies

Study	<i>N</i>	Language features	Target language	Learning Context	L2 proficiency	Treatment duration	Group division
Abrams (2003)	96	Speaking Grammar Vocabulary	German	FL	Mid	Not reported	Pair/ group
Blake (2009)	34	Speaking	English	SL	Mid	Mid	Class
de la Fuente (2003)	24	Vocabulary	Spanish	FL	Low	Short	Pair
Hirotoni (2009)	55	Speaking Grammar Vocabulary	Japanese	FL	Mid	Long	Group
Kost (2004)	94	Speaking Writing	German	FL	Low	Long	Pair/ group
Loewen & Erlam (2006)	31	Grammar	English	SL	Mixed	Not reported	Class
Payne & Whitney (2002)	58	Speaking	Spanish	FL	Mid	Long	Group
Satar & Ozdener (2008)	90	Speaking	English	FL	Mixed	Mid	Not reported
Sequeira (2009)	56	Speaking Grammar	Spanish	FL	Low	Long	Pair
Yilmaz & Yuksel (2011)	24	Vocabulary	Turkish	FL	Low	Short	Pair

Note. Oral performance = speaking; grammatical competence = grammar; lexical development = vocabulary; writing performance = writing.

two studies' interventions lasted for less than one week (*short*). The two remaining studies did not report the duration of the treatments.

To further investigate the features of SCMC activities used in the treatments, how learners were grouped within the different studies was also classified. Five studies asked learners to do pair work, and four studies divided learners into groups of three to six people. Two studies administered activities and instruction with the whole class online. One study did not report its grouping arrangement.

Different from Sauro's recent review on SCMC on SLA (2011), where the predominance of the past research considers the development of grammatical competence, seven of the 10 studies we reviewed addressed how SCMC could contribute to learning effects of L2 oral skills. Some investigated measures of lexical and grammatical knowledge being transferred to speech production in terms of the spoken languages' lexical richness, lexical density, and syntactic complexity (Abrams, 2003; Hirotoni, 2009), accuracy of word choice (Hirotoni, 2009), and accuracy of vocabulary and grammar use (Payne & Whitney, 2002; Satar & Ozdenar, 2008). Predominantly focusing on oral fluency, Blake (2009) compared the development of oral fluency development by 34 ESL students under face-to-face, SCMC, and control contexts, and found that students who engaged in text-chat achieved significantly greater gains in multiple

measures of fluency than did the control group or the face-to-face group. Sequeira (2009) examined how 56 ninth- or tenth-grade Spanish learners used either SCMC or face-to-face communication in order to promote oral fluency, and found that the SCMC group performed better than the other group in terms of increased means of language production. Two studies concerned lexical performance. Yilmaz and Yuksel (2011) examined whether an SCMC group or face-to-face group of English speakers would more effectively learn new Turkish words. This was evaluated through recasts on oral tasks, and these researchers found that the SCMC context was superior. Kost (2004), recruiting four sections of beginning German learners, examined their interlanguage development considering accuracy, performance, and communication strategies. She compared how SCMC and oral role-plays over one semester helped the groups acquire overall German performance. Kost found no significant difference across the four sections of low level German learners; however, participants' self-reported data indicated the noticing of their peers' grammatical mistakes, which was perceived to help them turn input into intake. The last two studies used form-specific tests to measure the development of lexical or grammatical knowledge as a result of SCMC interaction or interventions conducted via SCMC: de la Fuente (2003) analyzed the development of receptive and productive knowledge of food-related Spanish nouns. Loewen and Erlam (2006) investigated the effect of computer-mediated corrective feedback.

The Overall Effectiveness of Text-Based SCMC

To answer the first research question about the overall effectiveness of text-based SCMC on second language acquisition, we calculated the effect size values (Cohen's d) and unbiased standardized mean difference effect sizes (Hedges' g) on immediate post-tests for each study sample contrast g (based on the sample size of the 10 primary studies), as shown in [Table 2](#). Since some primary studies have more than one experimental group or control/comparison groups, these studies yielded more than one effect size measure because of the calculations resulting from the different contrasts between the different groups (as marked with 1 to 4, see [Appendix A](#) for details). Altogether, there were 19 comparison groups which allowed the calculation of effect sizes across the 10 studies. In [Table 2](#), the unbiased effect sizes (g) range from -1.23 to 1.55, with 14 positive (four large, three medium, six small) and five negative effect sizes; this demonstrates that the effect sizes obtained in these studies tend to be small. Among the 10 primary studies, only two studies (de la Fuente, 2003; Loewen & Erlam, 2006) administered delayed post-tests, so the effect sizes based on delayed post-tests could not be calculated across all studies. The weighted mean effect size across the 10 single SCMC studies was $m = .33$ (small); however, the confidence interval of .18 to .49 indicates that the result is statistically significant as the confidence interval does not include zero (Norris & Ortega, 2009). Thus, text-based SCMC had a statistically significant but small-sized overall effect on the participants' language acquisition, compared with face-to-face communication, APMC, or voice-chat. Moreover, the Q value of the 19 effect sizes ($Q = 47.686$, $p < .05$) shows that the variation between the effect sizes might be caused by variables other than sampling error.

Contextual Factors Influencing the Between-Study Variation of the Effects of Text-Based SCMC on SLA

Following Plonsky's meta-analysis (2011) on the effectiveness of L2 strategy instruction, the following variables are hypothesized to be relevant to the overall effects of SCMC for L2 learning: L2 proficiency levels, second vs. foreign language environments (SL and FL, respectively), target languages, and length of treatment (also in Norris & Ortega, 2000). In designing SCMC treatment tasks, group size has been a pedagogical concern (e.g., Liu & Sadler, 2003); thus, ways of group division (pair, small group, or whole class) is considered a possible factor for variation. The weighted mean effect sizes (g) and 95% confidence intervals for all studies and subgroups which represented the different contextual factors (levels of language proficiency, treatment duration, learning contexts, target languages, and ways of group division) were calculated and are shown in [Table 3](#). The findings help us see which contextual factors of text-based SCMC influenced L2 learning in these studies.

Table 2. Individual Biased and Unbiased Effect Sizes on Immediate Post-Tests

Study	Label	Biased effect size (Cohen's <i>d</i>)	Unbiased effect size (Hedges' <i>g</i>)
Satar & Ozdener (2008)	2	1.57	1.55
Sequeira (2009)	–	.87	.86
Yilmaz & Yuksel (2011)	1	.87	.84
Payne & Whitney (2002)	3	.77	.75
Payne & Whitney (2002)	1	.66	.64
Payne & Whitney (2002)	4	.62	.60
Payne & Whitney (2002)	2	.52	.51
Yilmaz & Yuksel (2011)	2	.41	.40
Blake (2009)	1	.39	.38
Abrams (2003)	1	.36	.36
Blake (2009)	2	.24	.23
Kost (2004)	2	.09	.09
Loewen & Erlam (2006)	2	.07	.07
Abrams (2003)	2	.02	.02
Kost (2004)	1	-.08	-.08
Hirotnani (2009)	–	-.10	-.10
Satar & Ozdener (2008)	1	-.14	-.14
Loewen & Erlam (2006)	1	-.46	-.44
de la Fuente (2003)	–	-1.28	-1.23

Note. These studies have been listed in decreasing order of effect sizes.

L2 Proficiency Levels

We first calculated the weighted mean effect sizes of each L2 proficiency level. It was found that SCMC had small weighted mean effect sizes for learners at mid-levels ($m = .33$) and mixed-levels ($m = .39$). These results are statistically significant as the 95% confidence intervals (CI) of the two effect sizes did not include zero. As for the low-level learners, the effect size ($m = .21$) of SCMC was small and statistically not significant, as the 95% confidence interval (CI) included zero.

Treatment Duration

To investigate whether the amount of treatment as given in the SCMC communicative activities influenced the effectiveness of language learning, the effect sizes were calculated across the three pre-defined categories of treatment periods: long, mid, or short duration of the SCMC treatment. It was found that the SCMC studies had a medium positive effect when the treatment period was defined as mid ($m = .51$) and a small positive effect when the treatment duration was long ($m = .35$); both of these findings were statistically significant. As for the short treatment period, there was a small effect size ($m = .12$) that was not significant. Among the 10 primary studies, two did not report the duration of treatments. Thus, four effect sizes obtained from the two single studies were categorized into the subgroup of NA (i.e., not applicable) in Table 3, and the mean effect size ($m = .10$) was not statistically significant.

Table 3. Weighted Mean Effect Sizes for Immediate Post-Tests

	N	g	95% CI		Q value
			Lower	Upper	
All studies	19	.33	.18	.49	47.686* ($p < .05$, $df = 18$)
L2 proficiency level					
Low-level	6	.21	-.04	.46	
Mid-level	9	.33	.10	.56	
Mixed-level	4	.39	.06	.72	
Treatment duration					
Long	8	.35	.12	.57	
Mid	4	.51	.19	.84	
Short	3	.12	-.38	.61	
NA	4	.10	-.20	.41	
Learning context					
ESL	4	.08	-.36	.52	
EFL	2	.60	.22	.98	
FL	13	.28	.10	.45	
Target languages					
English	6	.39	.09	.66	
Spanish	6	.51	.22	.81	
German	4	.09	-.16	.34	
Japanese	1	-.10	-.87	.67	
Turkish	2	.61	.03	1.19	
Group division					
Pair/Group	13	.28	.10	.45	
Class	4	.08	-.36	.52	
NA	2	.60	.22	.98	

Notes. Confidence intervals that do not include zero are statistically significant; those that do span a zero value are not statistically significant. g = mean weighted effect size; CI = confidence intervals; Q = heterogeneity of single studies.

Learning Condition

To account for the effect of SCMC in different language learning conditions, the weighted mean effect sizes for ESL, EFL, and FL conditions were calculated. The results show that SCMC had a medium impact when the participants were learning in an EFL context ($m = .60$) and small impacts on the other two conditions ($m = .08$ for ESL, $m = .28$ for FL). Among the three 95% CIs of the three mean effect sizes, only the one for ESL was not statistically significant.

Target Languages

In order to see the difference of SCMC in learning different target languages, the weighted mean effect sizes for English, German, Japanese, Spanish, and Turkish were calculated. It was found that SCMC had medium effects on the subgroup of Turkish ($m = .61$) and Spanish ($m = .51$), but small effects on the subgroup of English ($m = .37$) and German ($m = .09$), and a negative effect on the Japanese group ($m = -.10$). Based on the 95% CIs, the mean effect sizes for the English, Spanish, and Turkish studies were shown to be statistically significant, but the 95% CIs for German and Japanese groups were not. It should

be noted that there was only one effect size contributing to the weighted mean effect size calculation for the subgroup of Japanese, so this particular result should be interpreted with caution.

Group Division

To address the variation of learners working either in small groups or as part of a whole class, the weighted mean effect sizes for the subgroups were calculated. One study (Satar & Ozdener, 2008) did not report how learners were grouped; three types of group divisions in the present study were found: pair/group, class, and NA (i.e., not applicable or not reported). The calculation results show that SCMC had small, positive effects on the subgroups of pair/group and class ($m = .28$ and $m = .08$ respectively), but a medium effect on the NA subgroup ($m = .60$). The mean effect size for doing SCMC activities with the whole class was not statistically significant (95% CIs: $-.36, .52$), a finding that deserves further investigation.

DISCUSSION

The primary goal of the present quantitative meta-analysis was to investigate the magnitude of the effect of text-based SCMC on SLA. Given the 10 quasi-experimental or experimental studies chosen, it was found that the text-based SCMC had a small-sized but positive overall effect ($m = .33$) on SLA. Although the overall positive effect was small, there was a significant difference ($p < .05$) among the 10 studies. Compared with the known five meta-analyses in the CALL area with effect sizes ranging from .37 to 1.12 (Abraham, 2008; Taylor, 2006, 2009; Yun, 2011; Zhao, 2003), the effect size obtained from the present study was the smallest. In his meta-analytic assessment of the effects of technology use on language learning, Zhao (2003) found a large effective size of 1.12 from the nine studies included in his report. Yun's (2011) study of the effects of hypertext gloss on vocabulary acquisition obtained a relatively small effect size ($d = .37$) from 10 studies, very close to our statistic ($d = .33$). In instructed SLA meta-analyses, Norris and Ortega (2000) examined the overall instructional effect of L2 and found a large effect size of .96. Plonsky (2011) found a small size ($d = .49$) in a meta-analysis of L2 strategy instruction and Lee and Huang (2008) found an even smaller effect size ($d = .22$) when they examined the effects of input enhancement on SLA. Given all the meta-analytic reports cited here, our sample size was larger only than that of Zhao (2003). The small sample size may contribute to the small effect obtained from the present study: across the time span between 1990 and 2012, only 10 studies which used an (quasi-) experimental design to address the effectiveness issues of applying SCMC to L2 learning were found. The number of studies analyzed is indeed small and indicates an urgent need for more research along this line if researchers serious hope to understand further the effects of SCMC for language learning.

Nevertheless, we suspect that the complex nature of SCMC interaction and the many contextual variables involved in the implementation of SCMC tasks may be the main reason contributing to the small overall effect. As our analysis of the five contextual variables shows that variations in L2 language proficiency, target language, learning conditions, treatment duration, and grouping dynamics are likely to influence learners' language learning through SCMC interaction. It was found that SCMC had small positive effects on most subgroups of the five contextual factors. However, because of the small sample sizes of certain subgroups of the factors, it was hard to conclude which contextual variation was essential for SCMC to cause effects. Nevertheless, based on the results, we were able to illustrate a picture of SCMC effects on each contextual factor. For learners' L2 proficiency levels, the results indicated that SCMC had more impact when participants were in a mid- or mixed-level class setting. It is assumed that beginners might not have enough L2 proficiency to negotiate with interlocutors very successfully. As Loewen and Erlam (2006) discussed, some target items or language skills required for the SCMC tasks may be beyond the learners' development stages. Therefore, compared with beginners, learners with an intermediate level of target language benefit more, given certain SCMC task designs with specific target language features. None of the 10 studies included advanced learners; further investigation studying this type of learner is needed.

As to the treatment duration, the results showed that text-based SCMC had statistically significant

positive effects for mid- and long-term periods. It seems to suggest that at least one-week duration of SCMC treatment is essential for there to be any effect. Further examination of treatment design in the primary studies suggests that whether participants received SCMC treatments regularly during the treatment period may be a factor that influenced the effect of SCMC. Most of the primary studies with a mid-period (one to 10 weeks) or a long-period (more than 10 weeks) treatment duration involved participants in the SCMC treatments regularly. That is, students were required to complete SCMC tasks or to participate in SCMC sessions every few days or every week. Payne and Whitney (2002), for example, designed two online classes for students every week during a 15-week semester. Satar and Ozdener (2008) involved participants in one outside-class chat session every week during their four-week treatment. Even though the treatment duration of the two studies was different, both asked participants to use SCMC tools periodically. It seems that at least one-week regular practice is needed for SCMC treatments to have some effect.

As for learning conditions and target languages, it was found that SCMC had a medium impact for the subgroup of EFL context, and also medium effect sizes for the language subgroups of Spanish and Turkish. It should be noted, however, that the sample size of each subgroup was quite small and the results tended to be determined by certain studies. Further examination based on a larger number of samples of the two contextual factors (learning conditions and target languages) is needed to gain a better scope of how language learning context and target language affect the effect of SCMC.

When it comes to the group division, it was not surprising that SCMC had a better effect when participants were divided into pairs or groups than doing activities as part of a whole class. Instead of being passive learners in a whole-class discussion, participants had more opportunities for interactions and negotiations when they did online tasks with group members and interlocutors (Payne & Whitney, 2002). Pair work in either CALL or non-CALL contexts has been recommended as better learning conditions than groups with a larger size as the former arrangement allows more intensive discussion and easier group management (Hu, 2002; Liu & Sadler, 2003; Miao, Badger, & Zhen, 2006; Villamil & De Guerrero, 1998). In reporting a SCMC study on peer review, Liu and Sadler (2003) found that too many members, instead of the synchronous mode itself, in their arrangement caused chaotic flows of online messages.

SCMC research so far has discussed the benefits of SCMC in terms of learner participation (e.g., Kern, 1995), quantity of output (Sequeira, 2009; Sullivan & Pratt, 1996), quality of discourse (e.g., Chun, 1994; Warschauer, 1996a), increased motivation (Warschauer, 1996b), and reduced communication anxiety (Satar & Ozdener, 2008). This meta-analysis provides evidence that SCMC has positive effect on various aspects of L2 learning. Pedagogically, the initial analysis of contextual variations suggests that intermediate learners may benefit more from SCMC tasks if they are grouped into pairs or small groups and participate in the SCMC interaction on a weekly basis. In seeking to understand whether communication opportunities in SCMC lead to L2 acquisition, complications arise as we try to align results from SCMC primary studies to the SLA interactionist research mainly because most SCMC studies provide little description of the tasks implemented. Descriptions of SCMC tasks relative to the interactionist approach such as planning time, types of task prompts designed to generate discussion, and rationale of task sequence were generally very sparse. Carefully documenting how the SCMC tasks are structured is crucially important in future studies because descriptions of SCMC conditions and processes allow us to further analyze the kinds of interactions fostered in different SCMC tasks. Recent attempts such as Baralt (2010) and Collentine (2010) have demonstrated such a direction on task complexity and sequence as related to language learning outcome variables such as linguistic complexity. Unfortunately, their research designs did not provide essential statistical information for us to include them and compare them with the 10 studies in the current meta-analysis. With a more transparent characterization of SCMC conditions in future effectiveness studies, we can then ascertain which features may or may not trigger the processes involved in SLA and truly capitalize on the communication opportunities afforded in SCMC environments.

In his meta-analytic review of the effectiveness of technology use in language learning, Zhou (2003)

reported that there is an “overall emphasis on the process rather than result of using technology in language learning” (p. 23). The lack of effectiveness research, and in particular the large-scale implementations of school-level efforts was evident in the small number of SCMC studies surveyed in our meta-analysis. While we recognize the value of process oriented research, which offers rich description of how language learning occurred through SCMC interaction, more efforts oriented towards empirical evaluation assessing the effectiveness of implementing SCMC for language acquisition can yield fruitful insights in how much L2 learning and progress we can expect from SCMC interaction.

CONCLUSION

The study aims to find the magnitude of effectiveness of using synchronous computer-mediated communication for L2 learning. After a careful literature survey, we chose 10 experimental or quasi-experimental studies which were published between 1990 and 2012 in either a journal article or a dissertation format, and calculated their weighted effect sizes. The results yielded a small but statistically significant, positive mean effect ($m = .33$) through the calculation of 19 weighted effect sizes. This indicates that the SCMC groups in the 10 studies, on average, performed better than their counterparts who used either ACMC, face-to-face interactions, or voice-chats. The analyses of the contextual factors suggest that intermediate learners may benefit more from SCMC tasks if they are grouped into pairs or small groups and participate in the interaction on a weekly basis.

Pedagogical Implications

As shown in the study, SCMC can serve as an effective tool for enhanced L2 learning in traditional classroom instruction. Teachers should consider designing pair or small-group communication tasks for students to practice what they have learned in class (Abrams, 2003; Payne & Whitney, 2002). In online communication settings, learners cannot obtain clues of gestures or facial expressions via text chats in order to assume the interlocutors' intentions; they are pushed to use language itself to communicate with others. In this way, SCMC could serve as a “conversation simulator” in language learning to develop learners' speaking skills (Payne & Whitney, 2002, p. 25). Moreover, the chat logs could be saved in computers, so students could read their messages and check their language use after the tasks. However, because text-chat is a written form, it could not completely substitute for face-to-face communication or voice-chat.

Limitations and Suggestion for Future Research

The present meta-analysis has several limitations. First, because of the very limited number of the unpublished doctoral dissertations, and exclusion of unpublished reports and non-English reports, a certain level of publication bias existed in this study. More primary studies should be conducted to examine the text-based SCMC effects on L2 grammatical competence, pragmatic development, writing performance, and vocabulary acquisition. The present study also did not include qualitative primary studies that examined the sociocultural, discourse, and strategic aspects of language learning and use.

We have several suggestions for future research. First, more detailed description of tasks including implementation procedures (e.g., planning time) and designs of tasks (e.g., prompts) used to facilitate discussion would help CALL scholars identify more precisely the variables that have a definitive or major influence on L2 learning effectiveness in SCMC contexts. Second, as the effectiveness of text-based SCMC on learners' learning process and affective aspects is not easily observed through quantifiable measures, a qualitative research synthesis (e.g., including case studies, as suggested by Storch and Wigglesworth, 2010) that not only reviews the obtained results but also addresses the effects of SCMC on second language learning process and the reasons to both the effective and ineffective SCMC instruction could be conducted to obtain a better picture of its impact on SLA. Third, since there were few primary studies involving advanced learners in using text-based SCMC, more primary studies could target at advanced learners to see whether the learners with the L2 proficiency level higher than intermediate level

could benefit from SCMC more. Last, few studies (only two of 10 in our study) have involved a delayed posttest; thus, the retention effect of SCMC on language learning is unable to be determined. Future research should have a design which incorporates an assessment beyond an immediate post-treatment observation.

APPENDIX A. Coding Manual

Feature	Name of features	Definition of the features
1	Study ID	Assign an identification number to each study
2	Author	First name + last name
3	Publication year	The publication year
4	Publication type	1. journal article 2. doctoral dissertation
5	Participants' L2 proficiency level	The participants' second language proficiency level, e.g., low, mid, and high levels
6	Participants' education level	The participants' education background. e.g., college level
7	Learning context	The participants' learning environment, e.g., ESL, EFL, FL
8	First language (L1)	The participants' mother tongue
9	Target language (TL)	The L2 that was examined in the study
10	Independent variable (IV) (intervention)	The intervention given to the participants in the study, e.g., using SCMC tools to complete the tasks
11	SCMC tool	The SCMC software used in the study
12	SCMC activity	The activities in the study. e.g., jigsaw, information-gap, discussion
13	Treatment length	The time spent on doing each SCMC task
14	Treatment duration	The duration of undergoing the treatment for the participants
15	Dependent variable (DV) (TL measures)	The variable to measure or assess the effects of independent variable, e.g., test scores and ratings
16	Target language features	The language aspect that was examined. e.g., lexical development, oral performance, grammatical competence
17	Pretest	The type of the pretest and the measurement
18	Posttest	The type of the posttest and the measurement
19	Delayed posttest	The type of the delayed posttest and the measurement
20	Sample size	Total sample size of this study
21	Research design	1. Between subjects (with a comparison group) 2. Between subjects (with a true control group) 3. Between subjects (with more than one text-based SCMC groups) 4. Within subject A. pretest B. posttest C. delayed posttest
22	Experimental group (EG)	Which group it was in the study, e.g., SCMC group; the group sample size was _____
23	Comparison group (CG)/ True control group (TG)	Which group it was in the study, e.g., ACMC group, face-to-face group, true control group (no intervention); the group sample size was _____
24	Data collected for analysis	The data collected for the analysis in the study, e.g., test scores, questionnaires, chat log transcripts

APPENDIX B. Summary of Coding of the 10 Primary Studies

Study ID	Author (Year)	Article type	L1	Context	TL	Proficiency	Intervention	SCMC activity
01	Abrams (2003)	1	English	FL	German	Mid	SCMC & ACMC activities	Discussion
02	Blake (2009)	1	Arabic Chinese German Japanese Korean Polish Spanish Turkish	ESL	English	Mid	SCMC & F2F interaction	Free chat, discussion
03	de la Fuente (2003)	1	English	FL	Spanish	Low	SCMC & F2F activities	Information gap
04	Hirotnani (2009)	1	Chinese English Korean	FL	Japanese	Mid	SCMC ACMC F2F activities	Discussion
05	Kost (2004)	2	English Filipino Japanese Lithuanian Russian Spanish Swedish Tagalog	FL	German	Low	SCMC & F2F activities	Role play, discussion, communication tasks
06	Loewen & Erlam (2006)	1	Arabic Chinese French German Japanese Korean Portuguese Spanish Thai	ESL	English	Mixed	SCMC corrective feedback	Retell the story
07	Payne & Whitney (2002)	1	English	FL	Spanish	Mid	SCMC & F2F activities	Role play, discussion, communication activities
08	Satar & Ozdener (2008)	1	Turkish	EFL	English	Mixed	Text & voice chat activities	Information gap, problem solving, jigsaw, decision making
09	Sequeira (2009)	2	English	FL	Spanish	Low	SCMC written exchanges	Inclass interaction
10	Yilmaz & Yuksel (2011)	1	English	FL	Turkish	Low	SCMC activities	Vocabulary learning tasks

Notes. Article type: 1 = journal article; 2= doctoral dissertation. TL = target language.

APPENDIX B. Summary of Coding of the 10 Primary Studies, continued.

Study ID	Duration	Group division	SCMC inter-locutor	Examined TL features	Measures	N	Research Design	EG	CG/TG
01	n.r.	Pair/group	NNS	Oral grammatical lexical	Oral performance measures	96	1, 2 A, B	SCMC	CG: ACMC TG
02	6 weeks	Class	NNS	Oral	Oral fluency measures	34	1, 2 A, B	SCMC	CG: F2F TG
03	2 days	Pair	NNS	Lexical	L2 word meaning tasks	24	1 A, B, C	SCMC	CG: F2F TG
04	1 semester	Group (3-4 people)	NNS	Oral, grammatical lexical	Oral performance measures	55	1 A, B	SCMC	CG: ACMC
05	1 semester	Group (2-3 people)	NNS	Oral Writing	Oral and written measures	94	1, 2 A, B	SCMC	CG: F2F TG
06	n.r.	Class	NNS & instructor	Grammatical	Grammar judgement test	31	2, 3 A, B, C	SCMC (Implicit & explicit feedback)	TG
07	15 weeks	Group (4-6 people)	NNS	Oral	Oral proficiency measures	58	1 A, B	SCMC	CG: F2F TG
08	4 weeks	n.r.	NNS	Oral	Speaking proficiency measures	90	1, 2 A, B	Text-based SCMC	CG: voice-chat TG
09	1 semester	Pair	NNS	Oral, grammatical	Oral proficiency interview (OPI)	56	2 A, B	SCMC	TG
10	1 day	Pair	Researcher	Lexical	Oral production	24	1, B	SCMC	CG: F2F TG

Notes. n.r. = not reported; *N* = sample size; EG = experimental group; CG = comparison group; TG = true control group; F2F=face-to-face.

In the research design column (also refer to Appendix A for detail), 1 = between subjects (with CGs); 2 = between subjects (with a TG); 3 = between subjects (with more than one EG); 4 = within subject. A = with pre-tests; B = with post-tests; C = with delayed post-test

NOTES

1. A comparison group in an SCMC study is the group of subjects that used ACMC or face-to-face communication, whereas a true control group is one that does not receive any intervention.
2. Even though some experimental groups undertook other kinds of activities (e.g., face-to-face activities), as long as the independent variable of the study was SCMC intervention, the experimental group was still regarded as an SCMC group in the present meta-analysis. In Payne and Whitney (2002), the experimental group did have both SCMC and face-to-face classes during the experiment period.

However, the same face-to-face class was taken by both the experimental and the control groups. The only difference between the two groups was the way of doing certain activities. As Payne and Whitney (2002) stated, “the students in the experimental groups meeting online in the chatroom engaged in the same activities on the same days as those in the control groups did face to face” (p. 18). Therefore, we still regard the experimental group as a SCMC group since the difference between them and the control group was the use of SCMC.

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