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The effect of rate of speech and distributed practice on the development of listening comprehension

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The effect of rate of speech and distributed practice on the development of listening comprehension

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This study investigated the effects of training learners of English as a foreign language with different rates of speech and controls over speech rate. Subjects were put into one of four treatment groups: (A) trained on listening comprehension materials recorded at a fast speed, (B) trained on slow recordings, (C) given some choice about the speed, and (D) allowed sometimes to pause playback. The group that was trained on slow materials fared the best, apparently because their bottom-up processing improved. Other groups seem to have developed their strategic listening skills more, but these did not always transfer as well to other contexts. It was also found that learners performed better when they paced their training over several days.

Keywords: listening comprehension; CALL design; distributed practice; rate of speech

Introduction

Is it more helpful to a second language (L2) learner’s development of listening comprehension to hear slow, clear speech, or does one learn more when exposed to the language as it is naturally spoken? Authenticity seems to argue for choosing faster speeds. On the other hand, L2 learners require a certain amount of awareness to master an L2 (Schmidt, 2001; Swain & Lapkin, 1995; VanPatten, 2004), and noticing of vocabulary items and grammar structures is less likely to happen if the stream of words rushes by too quickly for the language learner.

Rate of speech can be especially important in the development of computer-assisted language learning (CALL) materials. Typically, listening materials in CALL are pre-recorded, and learners work independently, without a teacher nearby adjusting the rate of speech according to learner needs. One possibility would be to give learners control over the speed of delivery. But would learners make good use of such options, or could they at least be trained to do so? To evaluate that, one needs an understanding of the impact of rate of speech on second language acquisition (SLA) and the development of listening comprehension. The present study was conducted to address these issues.

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Literature review

Listening comprehension

In listening comprehension (LC), many types of processing work together. The skills that comprise LC can be divided into two basic types: bottom-up and top-down (Flowerdew & Miller, 2005; Rost, 2002; Rubin, 1994). Bottom-up skills involve decoding acoustic input, word recognition, and parsing. Top-down skills involve the application of contextual information and general world knowledge onto the raw data that linguistic processes present for interpretation. Where bottom-up decoding skills fail, top-down strategic skills can be called in to compensate (Rost, 2002).

Exactly how bottom-up skills interact with top-down skills, and which skills carry the greatest weight in accomplishing LC depends on what is being listened to and the context surrounding the occasion (Dunkel, Henning, & Chaudron, 1993; Rubin, 1994; Vandergrift, 2004). For both L1 and L2 listening, when the difficulty of comprehension is increased by one factor, it can be counter-balanced by ease of comprehension resulting from another factor (Bradlow & Pisoni, 1999), and for a given task, different skills are used by different people to accomplish the same result (Gorsuch, 2004; Wu, 1998). Successful L2 LC requires employing a range of listening strategies (Rost, 2002; Vandergrift, 2003). Failing to adjust which strategies one employs in a new listening task may impede comprehension (Bacon, 1992).

Working memory

When LC fails, it is often because working memory (WM) has been overtaxed (Carpenter, Miyake, & Just, 1994). WM is not only a place of temporary storage for information; it is also the place where any necessary operations are done on that information. In LC, the memory of a spoken message is held in WM, and this is also where parsing and related processes happen. When WM gets overloaded, some of the information is lost and/or the operations are not fully executed. Thus, a word or phrase that could be understood in isolation may not be comprehended if heard in the midst of challenging oral input.

Overloading WM is often related to speed. Graham (2006) investigated what learners experienced as the sources of their problems in L2 listening, and the factor most often identified was that of the input being too fast. Goh (2000) also examined LC difficulties encountered by learners of English as a foreign language (EFL) and found that the top problem was quickly forgetting what was heard. This could happen if new input is coming in too fast to properly encode what was recently comprehended.

Rate of speech

Some studies have found that a slower rate of speech allows L2 learners to comprehend significantly more (e.g. Chaudron, 1988; Griffiths, 1990), while others have not (Blau, 1990; Rader, 1990). Zhao’s (1997) explanation for these inconsistencies was that what was considered “fast” speech in some experiments was considered slow in others.1 In Zhao’s (1997) study, the subjects could choose between recordings at 100, 125, 150, 175, and 200% of the original rate of speech. Subjects scored significantly better on comprehension questions when allowed to choose the speed. They demonstrated even greater comprehension in the condition where they were, in addition, allowed to pause and repeat sentences. Blau’s (1990)
study found that the addition of regularly inserted pauses into a fast recording significantly improved L2 learners' comprehension.

Jensen and Vinther (2003) compared groups of language learners who were trained on different combinations of fast and slow repetitions of video dialogues. The pre-test and post-test were rated in terms of global comprehension, phonological decoding, and grammatical accuracy. The group trained on fast-only (original speed) listening showed fewer gains in grammatical accuracy than the groups exposed to slowed-down input. It appears that all groups were processing meaning and sound information more or less equally, but the groups that were exposed to slowed-down audio were able to process grammatical information more.

**Attention**

Both L1 and L2 listeners sometimes comprehend spoken texts by by-passing grammar and using common sense and contextual cues to weave together a message from understood words (Ferreira, Bailey, & Ferraro, 2002; VanPatten, 2004). So little are grammatical cues necessary in listening that Mecartty (2000) found that only lexical knowledge, and not grammatical knowledge, significantly accounts for LC ability among L2 learners. Because grammatical information is not as essential for comprehending a spoken message, it is likely to be ignored during a difficult comprehension task (VanPatten, 2004). It may be only during simpler comprehension tasks – for example, when the rate of speech is slower – that a learner has the extra cognitive resources necessary for the additional process of noticing grammatical forms.

When an L2 learner’s WM is completely occupied by a listening task, the possibilities for the learner to use the aural input for further language acquisition are limited or precluded. “... SLA is largely driven by what learners pay attention to and notice in target language input” (Schmidt, 2001, pp. 3–4), and noticing entails not only detection but also rehearsal in short term memory (Robinson, 1995). These operations are necessary for SLA but cannot happen while mental resources are entirely engaged by a more immediate listening task.

**Attentional demands specific to LC**

Listening tasks can place high demands on the perceiver’s attention because typically one does not have control over the manner of delivery. Unlike with reading, where one can usually slow down and return to previous sections, listeners must comprehend words at the rate at which they are spoken and integrate them into the oncoming stream at the moment. Garden pathing, which is to begin to misinterpret a sentence based on a misclassification of a word, and the alternative “wait-and-see” approach can both put heavy strains on WM, making an interruption in comprehension likely (Mitchell, 1994). More advanced L2 listeners and native speakers do not suffer as much from these complications because LC is largely automatic for them and thus makes negligible demands on WM.

**Applications of CALL to LC**

One important way that technology can be used to promote the development of LC is by providing learners with compelling, interesting material (McBride, 2009; Rost,
Technology can also aid in the development of LC by enhancing input (Chapelle, 2003). Hulstijn (2003), using a connectionist model of LC, explains how software providing written transcripts and repeated exposure, can help to automize bottom-up processing. Slowing the rate of speech down is another one of the primary ways that technology can help learners approach authentic materials (Robin, 2007), as we have seen in Zhao (1997) and Jensen and Vinther (2003).

Research questions

Three conditions that can enhance LC for L2 learners are slower rates of speech (Griffiths, 1990; Zhao, 1997), having a choice over the rate (Zhao, 1997), and pausing (Blau, 1990). Vandergrift (2004), however, questioned the pedagogical usefulness of these, saying that they might not prepare learners to comprehend normal spoken language. The present study was designed to investigate what effect these features would have on the development of learners’ LC and SLA. Four experimental groups were established:

(A) Fast. During training, those in Group A always heard dialogues recorded at a fast speed, which was operationalized at 180 words per minute (wpm).

(B) Slow. During training, those in Group B always heard dialogues recorded at the slow speed of 135 wpm.

(C) Choice of speed. Like all participants, members of Group C heard each dialogue in the training sessions twice. Special to this condition was that for the second listening, the Cs could choose to listen to the dialogue again at the fast speed (the first time was always fast), or they could listen to the dialogue the second time at 135 wpm.

(D) Pausing option. Members of Group D always listened to fast dialogues during training, but they were provided with a pause button during the second listening.

Therefore, two research questions were:

(1) Among the four experimental conditions, which group(s) show(s) the greatest improvements in LC?

(2) Where gains are found, do subjects improve on both speeds equally, or only on the speed they are trained on?

It was hypothesized that Group B (slow) would show the most gains because they would be trained with the greatest amount of comprehensible input. It was also hypothesized that the groups where the subjects had some control over the input (C and D) would show greater gains on an LC post-test than subjects in Group A. Thus, another question arises:

(3) To what extent do subjects avail themselves of control options (speed choice and pausing) when given them?

Finally, since the bottom-up skills of LC involve being able to process speech as quickly as it is spoken and to process words in the order that they are presented, these abilities were investigated under a condition that requires them while not
requiring the recognition of spoken (but instead written) words. This was done as a way of looking at bottom-up processing and its role in overall LC development. The last research question was:

(4) Does the ability of speeded, unidirectional written sentence processing correlate with LC, and does it improve proportionally to gains in LC?

The study
The experiment had a pre-test–treatment–post-test design and was conducted online. The tests were of two types: LC and a speeded, written sentence-comprehension task called the maze task. There were two versions of the LC test. Every other subject that logged onto the system was assigned Version A as the LC pre-test and later given Version B for the post-test; the rest took Version B as the pre-test and A as the post-test.

After taking the pre-tests, subjects were assigned to one of the four experimental groups in a semi-random fashion. All participants worked through 10 lessons as the training. One obligatory background survey was administered before the pre-tests, and additional, optional surveys were available after each lesson.

Subjects
The participants were native speakers of Spanish learning EFL. They were recruited from English classes at six universities in Chile. Table 1 shows the distribution of the subjects.

Students at Universities U and V were taking English as an elective course. Based on class observations, talks with the instructors, and the subjects’ self-assessment in the initial survey, these subjects’ LC was identified as ranging from novice to intermediate-mid on the ACTFL scale (ACTFL). The 16 students from the other campuses were English majors. These students ranged from beginner to advanced.

Subjects were not told that the experiment was looking at the effect of rate of speech. They were told instead that it was an experiment about online course design.

Materials
All materials can be viewed at http://www.slu.edu/colleges/AS/languages/Speech RateListening. The Appendix contains a sample of the materials.

LC tests
Both versions had two slow and two fast dialogues. Instructions and comprehension questions were in Spanish, while the dialogues were in English. Audio scripts were composed with between 90% and 95% of words from the top 2000 most frequent English words (English Centre at the University of Hong Kong, 2001). Participants heard the first half of each dialogue (ranging from 51 to 85 s), answered five multiple-choice comprehension questions, and then heard the second half of the dialogue and answered another five questions, totaling 40 questions per test. An illustration depicting the theme of the dialogue remained on the screen while the dialogue played, as shown in Figure 1.
Shohamy and Inbar (1991) found that listeners who have failed to comprehend a passage well may still be able to answer questions about specific details in the passage, but they are less likely to be able to answer global questions. Therefore, comprehension questions on the tests were written with this in mind, aiming for measures of global comprehension.

The tests were piloted on native English speakers and on native Spanish-speaking English learners to ensure that: (a) native English speakers scored 98% or better; (b) English learners with a higher level of English proficiency consistently scored higher than English learners of lower proficiency; (c) the two versions of the tests had the same level of difficulty; and (d) the procedures were self-explanatory. Piloting continued throughout development.

**Maze task**

In this procedure, each word of a sentence is presented alongside another word, and the task is to choose the one word that can combine with the word or words that preceded it to continue a grammatical sentence. Answers and reaction times are recorded. Figure 2 is an example of the series of screens that would make up one item. On the first screen, represented by the first box, there is only one word, and it is
on the left. The subject would hit the button that selects the word on the left. In order to successfully complete the sentence in this example, the subject would need to indicate the words in the following series: left–right–right–left–right–left–left–left–
right–right, producing the sentence “The family used to go to the beach every summer”.

This task requires one to fully assimilate each word in order. If one has not understood the sentence, one is left with no basis by which to make further decisions, which will eventually lead to an error (an item is stopped when a wrong choice is made). In this way, the task can measure comprehension without having to use comprehension questions. The maze task has proven sensitive to effects on comprehension and production, such as semantic well-formedness (Freedman & Forster, 1985), number agreement violations (Nicol, Forster, & Veres, 1997); and relative clause type, bias effects on ambiguous words, and word frequency (Forster, Guerrera, & Elliot, 2009).

The maze task used in the present experiment had 20 sentence items for which data were collected. Test takers were first allowed to run through five practice items as many times as they wanted. The test items were presented in random order to the test taker, but otherwise it was the same test that was used for all participants as both the pre-test and the post-test.

Training material

There were 10 LC lessons between the pre-tests and the post-tests, and these constitute what is here referred to as training. The lessons’ dialogues told the ongoing story of someone from the USA who travels to Chile. The situations and characters were meant to be ones the Chilean participants could relate to. In every lesson, the subjects first heard a full dialogue (86 to 312 seconds long) and then were given four multiple-choice questions, for which they got instant feedback. Afterwards, the subjects heard the same dialogue again, answered another four multiple-choice questions, and then answered two open-ended questions. The multiple-choice questions were meant to indicate to the participants how well they had understood, and to inform them about the storyline, to guide future listening. These questions were not written primarily for testing purposes.

Like the LC tests, lesson scripts used between 90% and 95% words from the 2000 most frequent English words. The LC tests and the lessons were made from the same template and so were similar in appearance. The same scripts and comprehension questions were used in all four conditions, with the only difference between experimental conditions having to do with speed and pausing, as explained above.

Recording the two speeds

It was decided to use naturally produced fast and slow speech, as opposed to making adjustments primarily through mechanical means. This way, the study’s findings could also inform decisions about selecting authentic materials and about whether and how to adjust one’s speech in L2 classrooms. The actors, all native speakers of English from the USA, first listened to a sample recording at the target rate of speech and were told how long their dialogue should last, given the wpm. For slow dialogues, they were told to speak clearly, as if talking to a non-native speaker whose LC was not very good. For fast dialogues, they were told to speak rapidly but naturally. The dialogues were recorded until they were within seconds of the target length and then expanded or contracted to the exact desired time using the 2xAV plugin for RealPlayer. In the case of the lesson dialogues, where two versions of each
dialogue had to be recorded, the same wording was maintained for both versions, although differences in pronunciation existed due to the rate of speech.

Surveys
All participants filled out an initial online survey about their previous L2 studies. Additionally, after each lesson, participants were invited to complete a survey about the lesson and its format. These post-lesson surveys asked questions about specific lessons and conditions and so, although all surveys shared some questions in common with other surveys, there were 40 distinct post-lesson surveys (viewable at http://www.slu.edu/colleges/AS/languages/SpeechRateListening). The post-lesson surveys were optional, and the response rate was about 70%.

Results
Because this experiment was openly available online, a large number (over 700) of people accessed the site. However, since participation was voluntary and required participants to work on their own time and equipment, was not compensated in any way, and required completion of 15 steps, only 141 participants finished everything. To compare those 141 to the 301 who did not finish but did take the pre-test, LC pre-test scores were subjected to an independent samples $t$-test. The difference between the means was non-significant ($p = 0.57$), which indicates that attrition was not connected to LC proficiency. Table 2 shows the numbers of participants in each group. These suggest that decisions to abandon the project were not the result of group assignment.

Results on the lessons’ comprehension questions were consistent among all groups. The fact that there is little variation in scores among groups is explained by the fact that, unlike the tests’ comprehension questions, the lessons’ questions were created primarily to aid participants in understanding the dialogues. Most participants reported finding the questions to be helpful, as seen in Table 3.

Table 2. Numbers of participants in each group at start and end of experiment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Began project</th>
<th>Finished all steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>118</td>
<td>39</td>
</tr>
<tr>
<td>B</td>
<td>116</td>
<td>32</td>
</tr>
<tr>
<td>C</td>
<td>103</td>
<td>32</td>
</tr>
<tr>
<td>D</td>
<td>105</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 3. Responses about the appropriateness of the comprehension questions.

<table>
<thead>
<tr>
<th>Group</th>
<th>Difficult (%)</th>
<th>Easy (%)</th>
<th>Helpful (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8.9</td>
<td>6.6</td>
<td>84.5</td>
</tr>
<tr>
<td>B</td>
<td>4.4</td>
<td>5.7</td>
<td>89.9</td>
</tr>
<tr>
<td>C</td>
<td>6.0</td>
<td>11.0</td>
<td>83.0</td>
</tr>
<tr>
<td>D</td>
<td>6.2</td>
<td>8.1</td>
<td>85.7</td>
</tr>
</tbody>
</table>
Table 4 shows participants’ answers as to how they perceived the speed, clarity, and naturalness of the actors’ voices in the lessons. The figures show for each group the percentage of that group’s survey responses to each of the six non-exclusive options. Additional comments about speed were many, frequently to say dialogues were very fast, but with some Bs noting the opposite. The most common observation was that the lesson dialogues were rather long (up to five minutes for Bs).

**The LC test**

Using all pre-tests, an independent samples *t*-test confirmed that Versions A and B of the LC tests were equally difficult, *p* = 0.66. The four experimental groups also began on equal footing. A one-way ANOVA indicated that there were no significant differences between the groups’ LC pre-test scores: *F*(3, 137) = 2.16, *p* = 0.10, or maze pre-test scores: *F*(3, 134) = 1.83, *p* = 0.14. Because of this, comparisons between the groups based on changes between their pre-test and post-test scores could be made.

Pre- and post-test scores are reported in Table 5. A general linear model repeated measures procedure with two within-subjects variables – dialogue speed (slow and fast) and test (pre- and post-test) – and one between-subjects variable – group assignment – was run to see what effect these variables had on the LC test scores. The main effect of speed was highly significant: *f*(1, 137) = 134.10, *p* < 0.001. Subjects got higher test scores on the slow dialogues.

The main effect of test was also significant *F*(1, 137) = 14.80, *p* < 0.001, but the change in scores went in the opposite direction from what was expected. That is, subjects did significantly worse on the LC post-test. Group membership was not significant, but the interaction between speed and group was: *F*(3, 137) = 2.94, *p* < 0.05. Because of this significant interaction, and because the effect of speed on the four different experimental groups was at the core of this experiment’s research questions, repeated measures procedures were run for each of the four groups separately.

### Table 4. Participants’ perceptions of lesson actors’ performances.

<table>
<thead>
<tr>
<th>Group</th>
<th>Clear</th>
<th>Good speed</th>
<th>Too slow</th>
<th>Too fast</th>
<th>Accented</th>
<th>Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20.1</td>
<td>34.7</td>
<td>1.3</td>
<td>26.7</td>
<td>7.9</td>
<td>9.2</td>
</tr>
<tr>
<td>B</td>
<td>29.0</td>
<td>46.4</td>
<td>5.1</td>
<td>1.8</td>
<td>3.6</td>
<td>14.1</td>
</tr>
<tr>
<td>C</td>
<td>22.3</td>
<td>37.0</td>
<td>0.7</td>
<td>25.7</td>
<td>6.5</td>
<td>7.9</td>
</tr>
<tr>
<td>D</td>
<td>27.5</td>
<td>39.4</td>
<td>0.2</td>
<td>18.6</td>
<td>8.5</td>
<td>5.8</td>
</tr>
</tbody>
</table>

### Table 5. Test averages and change scores.

<table>
<thead>
<tr>
<th>Group</th>
<th>Slow (out of 20)</th>
<th>Fast (out of 20)</th>
<th>Total (out of 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Change</td>
</tr>
<tr>
<td>A</td>
<td>15.23</td>
<td>14.33</td>
<td>−0.9</td>
</tr>
<tr>
<td>B</td>
<td>12.66</td>
<td>11.72</td>
<td>−0.94</td>
</tr>
<tr>
<td>C</td>
<td>13.94</td>
<td>11.81</td>
<td>−2.13</td>
</tr>
<tr>
<td>D</td>
<td>14.61</td>
<td>13.71</td>
<td>−0.9</td>
</tr>
</tbody>
</table>
The effect of speed remained highly significant ($p < 0.001$) for each group when examined separately, confirming that slow dialogues were easier to comprehend than the fast dialogues, on both the pre-test and the post-test.

The main effect of test was significant for only two groups, Group A, $F(1, 38) = 8.97$, $p < 0.01$, and Group C, $F(1, 31) = 6.05$, $p < 0.05$. This means that there was a significant drop in scores from pre-test to post-test. For Groups B and D, there was no significant change in scores from pre-test to post-test. The only group for which there was a significant interaction between speed and test was Group C, $F(1, 31) = 6.64$, $p < 0.05$. This indicates that the way in which scores changed from pre-test to post-test was different depending on the speed of the dialogue: a dip in scores happened with the slow dialogues, while fast dialogue scores remained essentially constant.

**The maze task**

The primary maze data used were the number of full sentences participants were able to complete. A significant correlation of 0.66 (one-tailed, $p < 0.005$) between LC pre-test scores and maze pre-test scores indicates a strong, positive relationship between the two measurements.

A repeated measures analysis found a significant, positive change in scores of sentence completion from pre-test to post-test, $F(1, 131) = 26.72$, $p < 0.001$, as well as an interaction between test gain scores and group, $F(3, 131) = 2.72$, $p < 0.05$. To further investigate this interaction, the data were split by group. It was found that gains in accuracy were significant for three groups, but not for Group A. For Group C, the dependent variable test was significant $F(1, 29) = 5.59$, $p < 0.05$. It was also significant for Group D, $F(1, 35) = 5.16$, $p < 0.05$. The effect was most significant for Group B: $F(1, 31) = 13.20$, $p < 0.01$.

The change in reaction time (from word choice to word choice) from pre-test to post-test was rather uniform between groups, and a repeated measures test showed no significant effect for group. The average reaction time on the pre-test was 2.2 seconds, and for post-test, 1.6 seconds.

**Summary**

To summarize, Group A showed a significant drop in LC scores and no significant gain on the maze task. Group C also showed a drop in LC scores on slow dialogues and a significant gain on the maze task. Groups B and D showed no drop in LC scores and made gains on the maze task, which was highly significant for B. This can be represented as follows:

$$A(\text{fast}) < C(\text{speed choice}) < D(\text{pausing option}) < B(\text{slow})$$

However, a general drop in LC scores after a training period in LC, for participants who were simultaneously enrolled in EFL classes elsewhere, is unexpected and suggests irregularities. Since many of the participants rushed through training, they may have negated the benefits of sustained, repeated practice. These possibilities were explored and the data consequently re-analyzed.
Reanalysis

Timing

Time stamps were recorded for every participant response, making it possible to code the data for number of separate days on which participants engaged in the project (mean of 4.8), over how many days this spanned (mean of 22.9), and how many activities were done consecutively with no breaks. Sixty-two percent of participants did half or more of the project all at once, and this factor had a $-0.20$ one-tailed correlation ($p < 0.01$) to change on the LC test and a non-significant correlation to maze change scores. Those who had paced their lessons displayed greater gains.

Because a benefit for distributed practice (with time between sessions) has been well established for both verbal memory tasks and skill learning (Cepeda, Pashla, Vul, Wixted, & Rohrer, 2006), it was decided to examine the data of only those participants who never completed half or more of the project at once. This data trimming left a reduced group (hereafter referred to as the “pacers”) of 53: 16 in Group A, 8 in B, 10 in C, and 19 in D. The pacers’ profile was compared to the larger groups. The distribution of schools attended is similar. Self-reports (on scales of 1–10) of ability in reading (6.4 for whole group, 6.9 for pacers), ability in LC (5.0 for all, 5.4 for pacers) and interest in improving their English (9.0 overall, 9.4 for pacers) suggest that the pacers were slightly more interested in bettering their English and moderately more advanced.

Among the Cs, decisions about whether to choose the slower speed in second-round listening on lessons were similar between the larger group and subgroup, as seen in Figure 3. With the Ds, use of the pause button was very low. It was used only

![Figure 3. Group C's election of slower speed.](image-url)
about 5% overall, and on roughly 6% of occasions by the pacer group. Comments in surveys indicated that sometimes use of the pause button could cause words to be cut off.

Pre-tests and post-tests
Table 7 shows the pacers’ test scores. In this subgroup, Group A continues to show the greatest decline. Groups C and D now show slight improvement on fast dialogues but drops on slow dialogues, especially Group C.

Group B shows a turnaround, from a non-significant tendency towards decline to now an improvement on both slow and fast. Planned contrasts revealed that they displayed significantly greater LC gains over other groups, $t(49) = -2.27, p < 0.05$, $r = 0.31$. Group B is also the group that shows the strongest gain scores on the maze task among pacers, although contrasts here were not significant. The correlation between LC and maze pre-test scores was still strong for the pacers: 0.48 (one-tailed, $p < 0.01$).

Discussion
Analyses of the full set of data indicated that Group B (slow) fared the best from the training, because it showed the strongest gains on the maze task, coupled with no significant drop in LC scores. The ranking of all four groups based on these two tests is:

$$A < C < D < B$$

However, one expects gains from training, and the lack of these on the LC test suggested that something unintended was happening during training. Large differences in the timing of subjects’ participation had been noted, and so the data

Table 6. Maze scores.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.51</td>
<td>13.32</td>
<td>0.81</td>
</tr>
<tr>
<td>B</td>
<td>10.06</td>
<td>12.84</td>
<td>2.78</td>
</tr>
<tr>
<td>C</td>
<td>9.94</td>
<td>11.26</td>
<td>1.32</td>
</tr>
<tr>
<td>D</td>
<td>12.58</td>
<td>13.61</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Table 7. Pacer test scores.

<table>
<thead>
<tr>
<th>Group</th>
<th>Slow (out of 20)</th>
<th>Fast (out of 20)</th>
<th>Maze scores (out of 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Change</td>
</tr>
<tr>
<td>A</td>
<td>16.00</td>
<td>15.69</td>
<td>-0.31</td>
</tr>
<tr>
<td>B</td>
<td>12.38</td>
<td>13.63</td>
<td>1.25</td>
</tr>
<tr>
<td>C</td>
<td>15.40</td>
<td>13.30</td>
<td>-2.10</td>
</tr>
<tr>
<td>D</td>
<td>16.16</td>
<td>15.32</td>
<td>-0.84</td>
</tr>
</tbody>
</table>
were re-examined to explore possible effects of practice distribution (Cepeda et al., 2006). A reduced data set was analyzed with only those participants who never completed half or more of the project at once. Change score trends among groups in the reduced dataset parallel those of the full group but are stronger.

\[ A < C < D < B \]

This suggests that the subgroup’s results might reflect the differences between the four experimental conditions more accurately because the pacers’ training was experienced as originally intended, with rests between lessons.

Like Zhao’s (1997) study on the effect of rate of speech on LC at a particular moment, a slower rate of speech yielded higher scores on comprehension questions, for all groups, at both pre-test and post-test times. The changes in scores from before and after training, however, show that participants confronted fast and slow dialogues quite differently at post-test time, depending on the experimental conditions they experienced. What follows is a discussion of why the answer to this study’s first research question is that the slow group fared the best, the fast group the worst, and C and D were in between.

As Group B was the only group to consistently train on slow dialogues, it appears that the slower speed aided their development of LC. As in Jensen and Vinther (2003), the WM of subjects who listened to slower passages was engaged but not overloaded by the demands of the task, and so they could perform additional mental operations such as noticing and rehearsal of features of the input, both of which are thought to be necessary for SLA (Robinson, 1995; Schmidt, 2001). Noticed features probably included not only grammatical structures and lexical items but also details about pronunciation. EFL learners in Chile often receive aural input from non-native and British speakers, and so some of what participants learned throughout the project was likely information about understanding the actors’ US accents (Clarke, 2003).

Group A (fast) was the group that displayed the worst post-test results, in both analyses. They are the only pacer group that showed drops on both fast and slow dialogues, and they showed the least gains on the maze task. When factors such as speed make bottom-up processing more difficult, as in the case of the As, top-down, strategic processing can compensate (Rost, 2002). After 10 practice lessons using compensatory processes to follow the storyline, it would be a natural approach for participants to try to employ the same practices during the post-test (McBride, 2008). However, the post-test dialogues lacked several characteristics necessary to support the same strategic behavior that could be used with the practice lessons. The test dialogues, unlike the lessons, were not part of an ongoing story whose characters the subjects had become familiar with. This could disrupt relying on schemata and strategies of inference. Test dialogues were also shorter, providing fewer redundancy cues and requiring more intense and unvarying concentration.

In contrast to the Bs, the As would not have been able during training to do the kind of rehearsing and noticing of features in the input necessary for SLA, because their WM had much more of the dialogue to process at any given moment, due to the greater speed. This could account for their comparatively low gains on the maze task. Because the maze task was a novel task at pre-test time, it is natural for all participants to show some gain on their second exposure to the task (the post-test), but the differences in gain scores on the maze task among the four experimental
groups suggest differences in the development of participants’ ability to quickly parse sentences word by word.

Because Ds made little use of the pause during the training, their input was essentially identical to that of the As, although their experience of the training, test results indicate, was not. Giving students control over their learning environment positively impacts their attitude, which then makes learning more likely to occur (Glasser, 1998). It is possible that the Ds felt less out of control than the As during training sessions because they knew they had the option to control the playback. This difference in their experience of the learning environment may have had a significant impact on their experience of the training and thus how much they were able to benefit from it. This could in turn account for their tendency, among pacers, to improve on fast dialogues.

The fact that the Ds, like the As, did worse on the slow section of the post-test indicates that the skills that they developed during training to comprehend fast dialogues were not entirely transferable to the task of listening to slow dialogues on the LC post-test. It may be that listening to slow dialogues requires a special kind of concentration – for example, not allowing one’s mind to wander off topic when not being fully challenged by the speed of the dialogue, nor having distracting thoughts about how the actors’ voices sounded slightly affected – that the Ds at post-test time failed to muster.

On the maze task, the pacer Ds showed roughly the same gains as pacer As, suggesting that having had only fast input during training resulted in a similar experience in this arena.

Finally, Group C displays an interesting interaction between speed and test. The pacer Cs’ slight improvement on fast dialogues indicates possible benefit from the training and the speeds they chose to listen to. The Cs’ sharp decline in performance with the slow dialogues indicates that, as with the Ds, the skills that the Cs were developing while working through the 10 lessons were geared towards comprehending fast and not slow dialogues. Since during training the Cs only heard slow dialogues after having already heard the dialogue once before at 180 wpm, they would not have listened to slow dialogues the way one must for a first and only exposure, as they later encountered in the post-test.

The Cs’ gain scores on the maze test lie somewhere between that of Group B, on the one hand, and Groups A and D on the other. Because the Bs were always trained and the Cs were sometimes trained on slower dialogues, this supports the argument that it was the extra reflection that slower dialogues afforded participants that helped them in their development of the ability to quickly parse sentences in the strict order that LC and the maze task impose. Still, 10 training sessions make a somewhat small number of lessons to result in differences in parsing abilities. However, the skill required on the maze task was not merely parsing sentences, but parsing sentences written by the same author who wrote the LC tests. Perhaps, 10 lessons would be significant in honing parsing skills within this restricted domain.

This study’s second research question asked whether participants would show gains on only the speeds they were trained on, or whether training benefits would transfer. Pacer Group B made greater gains on the fast speed although trained on slow dialogues, with parallel changes among all Bs. Groups C and D, having been forced to rely more on strategic, top-down listening skills during training, were able to apply these skills to the fast post-test situation but not for the slow post-test passages. Group A shows a worse performance in both conditions, suggesting
that Groups C and D benefited substantially from having learning environments that allowed them a measure of control.

The third research question asked about the choices learners would make given speed and pausing options. In the case of speed (Cs), we find that they experimented with the slower speed, chose it occasionally, and chose it less as time went on and they became more comfortable with the faster speed and the actors’ speech patterns. Another possible explanation for the decreasing popularity of the slow option might be that participants increasingly wanted to rush through the lessons as time went by.

The pause button was used very little. Survey comments indicate that this is perhaps because pausing sometimes caused words to be distorted. Still, test results suggest that its mere presence may have had a positive effect on participants’ experience of the lessons.

Another important finding, while not part of the original question, was that, given the choice, a majority of the participants preferred to do several steps of the project at once, instead of pacing out their lessons. While this may indicate their enjoyment of the lessons, it underscores the importance of distributed, sustained learning practice. Interestingly, Groups B and C had disproportionately smaller numbers of pacers, even though the presence of slow dialogues in some (C) or all (B) of their lessons meant that their lessons necessarily took more time.

The last research question concerned the maze task’s possible correlation to LC. The strong correlations between LC and maze scores, the significant change score results when analyzing data for all participants, and trends among pacers favored this conclusion.

Limitations of the study and future directions

It was felt that in order to recruit and retain a large number of participants for the study, few restrictions could be placed on them. Therefore, participants were allowed to log on at any time. As a result, 62% did half or more of the project at once. Those left in the pacer set may have been better language learners. The pacer dataset was sharply reduced, limiting statistical power, and the reduced experimental groups were uneven. There exists the possibility that choices about whether or not to pace lessons differed among the four experimental groups, in which case the score differences between the four pacer groups might not be due exclusively to the differences of the four experimental conditions.

Follow-up studies about speed and control features would benefit from tighter control over the circumstances and timing of participation, building in a motivation for the participants to perform their best throughout the experiment. Given many participants’ limited access to technology, they were sometimes forced to do their work in noisy, public computer laboratories. It cannot be known how that fact affected the results (Egbert, 2010).

Because the benefits of the slow dialogue training appear to be connected to WM, it would be interesting to investigate how learners’ different WM capacities interact with the experimental conditions, as would a systematic look at how the experimental conditions affect learners at different proficiency levels. There is evidence that more proficient learners make greater use of help options (Grđurović & Hegelheimer, 2007). Also, pre-test scores on the fast dialogues indicate that this task was quite challenging for many participants. Follow-up studies ought to use
materials more precisely matched to subjects’ proficiency levels, while at the same
time keeping the slow dialogues challenging enough as to avoid ceiling effects.

A higher quality pausing system should be used in future research to study
whether then participants would make greater use of the pause option. However, it
has been found that students do not always take full advantage of help options made
available to them (Grgurović & Hegelheimer, 2007). Thus, in order to thoroughly
investigate the potential of the kinds of help options explored in the present
study, participating learners should first be trained on how best to use the features
available to them (Kolaitis, Mahoney, Pomann, & Hubbard, 2006; Winke &
Goertler, 2008).

This study also indicates that future studies and CALL design should take the
effects of distributed practice into account. Finally, results suggest that the maze task
taps into bottom-up processing skills. Use of this relatively easy to construct testing
method could be used to further investigate LC.

Conclusion

This study investigated the effect over time of rate of speech on L2 learners’
development of LC and found evidence to suggest that exposing L2 learners to slow
and clear spoken input can encourage SLA. This is not to say that this should be
used all of the time – learners need to have exposure to a wide range of speaking
styles – but when introducing or practising new words or grammatical structures
with beginning to intermediate L2 learners, or when building up automaticity, a
slower, clearer style of speech that allows learners to notice details about the input is
appropriate.

Not only do learners need exposure to a variety of speaking styles, they need
exposure to a variety of listening tasks in order to develop a range of strategic skills
and an understanding of when it is appropriate to employ them. Learners also
appear to benefit from having speed and pausing options in LC, whether or not they
make much use of such options. Finally, the results provided strong evidence for the
benefits of distributed practice. SLA is aided by sustained practice over time.

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Dissertation Grant and by a grant from the Tinker Foundation. The author also wishes to
thank the anonymous reviewers for their insightful comments on an earlier version of this
article.

Notes

1. Griffiths (1990) used 100 words per minute for slow speech and 200 for fast speech; Blau
2. Two rules guided group assignment: first, to alternate in order (one participant in A, the
   next in B, etc.). At the same time, I tried to have an equal number, in each experimental
   group, of high-, average-, and low-scorers on the LC pre-test, as well as an equal number
   of people in each group who had taken Versions A and B of the pre-test.
3. All other words in the materials appeared in the Academic Word List (Coxhead, 1997) or
   (twice) they were pictured in the accompanying illustration, or they were cognates with
   Spanish words, borrowed words, interjections (e.g. “hmm”), or proper nouns.
4. Readers are encouraged to try some examples at the following website http://
   www.u.arizona.edu/~kforster/MAZE/start.htm.
5. The degrees of freedom are different here because maze pre-test scores were lost for three subjects, due to a problem with the network server.

Notes on contributor

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References


Appendix

*Test dialogue 1 (slow), Part I, From Test A*

C: Hi, Greg.
G: Hi, Cindy. How are you?
C: Good, thanks. So what’s this I hear you’re going to Spain for the summer?
G: Yes, we are going with my wife to visit her family in Spain.
C: Wow, that’s great. But isn’t it going to be hard to travel with two children?
G: Oh, yeah! There are a lot of things that I have to worry about that I wouldn’t have to worry about without kids. But it’s worth it. A lot of people in the family haven’t seen the new baby.
C: Oh, yeah, that’ll be so fun!
G: So, how about you, Cindy? What are your summer plans?
C: Mmm ... I’m not totally sure yet. I’ve got a job for the end of the summer, but I’m not sure what I’m going to do during the first month and a half.
G: Go on vacation!
C: Yeah, but that’s expensive.
G: Not as expensive when you don’t have two children to take with you.
C: True.
G: Besides, there are a lot of beautiful places to visit near here.

**Comprehension questions, translated into English**

1. Greg and Cindy are talking about their plans for ...
   *the weekend*
   *the summer*
   *spring break*
   They don’t say ...

2. Many people in Greg’s family haven’t met ...
   *his wife*
   *his baby*
   *the Spanish part of the family*
   *his adopted daughter*

3. Why does Cindy doubt that she should travel?
   She doesn’t want to leave her house unattended
   She is afraid of traveling
She’s hoping that her boyfriend will come to visit her
*It’s expensive

4. What is Cindy going to do at the end of summer?
She is going to go to Spain
*She is going to work
She is going to visit her parents
She is going to have a baby

5. Greg suggested that Cindy also . . .
go to Spain
*travel in the area where they live
tell her parents that they come visit her
go to NY, but during another part of the year

Maze task test items
The — / girl enter / winter that / kissed over / the forget / you boy / see is / named
talk / learn. Mary.

The — / should sister / that big / green likes / me observe / is minus / coming
study / inflation to / visit. didn’t.

The — / friend went / that the / vision called / primary me / interpret yesterday /
tragic told / yes me / the return / news. free.

The — / bought woman / that she / surprising we / helped operate / left window
this desert / bag send / explore. here.

The — / actor of / window that / off the / musician have / married energy / is
tornado / traveling forget / milk to / Rome. on.

The — / arrive uncle / circle that / flower visited / us answer / sent kilometer /
bring us / this calculator / very they / nice and / again. photo.

The — / professor wrote / her that / pencil recommended / you talk / direction is /
publishing relax / child a / new weren’t / sincerely. book.

The — / French please / woman him / egg that / he ready / no met / version
offered / to we / give pink / turn him / French month / lessons. because.

The — / for children / that his / we who / invited person / reason to / the
baseball / an party / played it / happily. our.

The — / my lawyer / any that / keep they / building hired / hair wanted / to fear /
change hotel / the sleep / terms those / tree of / multiply the / far. contract.

The — / of young / if couple / decided coffee / to said / buy newspaper / come a /
house. when.

The — / their man / fat visited / his leave / some family / in walk / Europe. even.

The — / criminal ours / interesting believes / his didn’t / those luck / transparent is /
shop finally / bicycle. changing.

The — / doctor me / insect recommended / fell more / exercise your / and
traditions / and a / healthier we / registered. diet.
Script for Lesson 8

Receptionist: Good afternoon
Karen: Good afternoon.
Receptionist: Checking in?
Karen: Yes. Name’s Fischer. F-i-s-c-h-e-r.
Receptionist: ... Karen?
Karen: That’s right.
Receptionist: (checking on computer) I see you’re staying here for 5 nights . . .
Karen: That’s right.
Receptionist: Single room.
Karen: Yes.
Receptionist: All right ... (typing into computer) I just need a credit card from you.
Karen: Here you go.
Receptionist: Thank you.
Receptionist: So what brings you to Arica?
Karen: I’m going to a conference. The Ninth International Conference for English Teachers. It’s at the University of Tarapaca.
Receptionist: Tarapacá.
Karen: Oh, is that how you pronounce it? Ha, ha, it kind of sounds like a bird call ¡Tarapacá!
Receptionist: I think it’s an Aymara word, but I’m not really sure what it means.
Karen: Well can you tell me how to get there? Is it far?
Receptionist: The university? No, it’s not far. It only takes 10 or 15 minutes by bus. The bus leaves right outside the hotel.
Karen: Can I go there by taxi?
Receptionist: Yes, of course.
Karen: I think I would rather do that. The company will pay for the taxi anyway, I see they’re not that expensive. I took a taxi from the airport.
Receptionist: No, taxis aren’t so expensive. And we can call a taxi for you from the hotel.
Karen: That’ll be great. But I’m not going until tomorrow morning.
Receptionist: Of course. And would you like a wake-up call, then?
Karen: Yes, that would be nice. Let’s say for seven.
Receptionist: Seven o’clock. Very well. So … are you an English teacher?
Karen: Sorry? Oh, no, I’m not. I mean, I was, but now I am working for a publishing company.
Receptionist: I love English.
Karen: Well, your English is excellent.
Receptionist: Thanks! So what books are you selling?
Karen: Actually, I’m not selling books; I’m selling educational CDs.
Receptionist: Oh yeah? Do you have a sample of one of your CDs that you could give me?
Karen: Er … maybe. I’ll have to see if I have any left over after I give them to my potential clients.
Receptionist: Yeah, see if you don’t have any extras. Because if you do, I would love to have one.
Karen: I’ll try to remember.
Receptionist: Thank you! So … do you need any help getting your bags to your room?
Karen: No, I think I’m okay. Thanks very much anyway.
Receptionist: Are you sure? Pablo here can help you.

Comprehension questions (translated), first half
1. What did Karen say about the name Tarapacá?
   *That it sounds like a bird singing
   She asked if it was an indigenous name

2. How does the receptionist suggest that Karen go to the university?
   By foot
   *By bus

3. What favor does the receptionist ask of Karen?
   *That she give her a CD-ROM
   That she always speak to her in English

4. What is the bellhop’s name?
   *Pablo
   There is no bellhop

Comprehension questions, second half
5. How did Karen get from the airport to the hotel?
   Someone from the hotel picked her up
   *She took a taxi
6. Karen decides that she prefers to go to the university by taxi. What comment does she make about the taxis when she decides this?
That the taxis in Chile don’t seem to be as dangerous as the taxis in Mexico
*That the publisher will pay her transportation expenses

7. What time does Karen want to wake up tomorrow?
At 5:00
*At 7:00

8. What does Karen say about the receptionist’s English?
That it is easy to understand
*That it is excellent

Open-ended questions
9. What would you suggest to Karen that she do her first night in Arica?
10. Describe how you imagine that Karen feels at that moment.