ABSTRACT

Sixty-eight college students enrolled in a French course listened to a multimedia-based French passage in one of four groups to which they were randomly assigned: the listening text (a) alone, with no annotations; (b) in pairs, with no annotations; (c) alone, with written and pictorial annotations; and (d) in pairs, with written and pictorial annotations. The students identified or recalled vocabulary best when working with both annotation types either alone or in pairs. However, when they worked collaboratively with annotations available, they showed the highest level of aural comprehension. These outcomes suggest that accessing pictorial and written annotations in multimedia listening comprehension activities, while one is collaborating with a peer, results in relatively high vocabulary recall and recognition, as well as improved aural comprehension.

KEYWORDS

Listening Comprehension, Multimedia, Text Annotations, Picture Annotations, Collaborative Learning

INTRODUCTION

In recent years, second language (L2) researchers have examined the effects of L2 multimedia components, such as written and pictorial annotations and advance organizer videos on students’ vocabulary acquisition and their listening or reading comprehension (e.g., Chun & Plass, 1996a, 1996b; Jones, 2004; Jones & Plass, 2002; Plass, Chun, Mayer, & Leutner, 1998). In response, some developers have created effective web and computer-based multimedia modules that further inquiry shows support this research and subsequent L2 learning (e.g., Chun & Plass, 1997; Sabo, Restrepo, & Jones, 2000; University of Texas, 2004). Despite advances, studies have only begun to delve into the capabilities of L2 multimedia; numerous L2 pedagogical strategies, in combination with multimedia, remain under-researched. As technology use continues to increase in education and L2 teaching, researchers need to examine current effective L2 learning strategies so as to facilitate technology and curriculum design and development.
Collaborative strategies that engage students in peer-to-peer interactive activities have long been shown to support L2 learning (e.g., Oxford, 1997; Reagan, Fox, & Bleich, 1994; Vandergrift, 1997; Vygotsky, 1978) and enhance students’ comprehensible input which, in turn, leads to greater understanding of aural and written texts (e.g., Szostek, 1994; Yano, Long, & Ross, 1994). In respect to collaboration and computer use, students have had positive experiences collaborating via computer-mediated-communication (CMC) as well (e.g., Hudson & Bruckman, 1992; Kern, 1995; Warschauer, 1997). However, there is little research on collaborative learning that involves multimedia (Chang & Smith, 1991), even though we continue to seek a better understanding of how multimedia and their various attributes can enhance L2 learning, and more particularly listening comprehension (e.g., Jones, 2003; Jones & Plass, 2002). Given that studies consistently reveal the effectiveness of collaborative learning in the general classroom and in CMC environments and that many multimedia components, including written and pictorial annotations, also benefit L2 learning, one must ask: How can peer-to-peer collaboration at an interactive multimedia module further enhance students’ L2 learning?

This article addresses the question of the effectiveness of collaboration and multimedia annotations on vocabulary learning and listening comprehension. I first provide an overview of what collaborative learning and learning with multimedia are, as well as give examples of collaborative learning in a computer-based environment. Following is a discussion of the findings of this study, the implications of collaborative L2 multimedia learning for language students, and suggestions for further research in the area of collaborative learning, L2 acquisition, and multimedia.

COLLABORATIVE LEARNING

Collaborative learning entails knowledge construction within a context in which students interact with one another to attain a common goal. Unlike cooperative learning, which is structured and hierarchical in nature, collaborative learning is dialogic and liberatory (Ede & Lunsford, 1990). Thus, knowledge enhancement depends upon the exchange of information between learners as they ask for clarification, verify each others’ understanding, and negotiate meaning as needed (Englander, 2002; Olsen & Kagan, 1992; Oxford, 1997; Reagan, Fox, & Bleich, 1994).

Vygotsky’s (1978) social learning theory supports collaborative learning in positing that through interactions with others, individuals can progress from their actual to their potential development level. The zone of proximal development (ZPD) is the distance that lies between students’ current and potential levels of development. When students discuss and interact together, they guide, support, and correct each other as needed and, thereby, share their knowledge and linguistic and cognitive resources to help each other progress through the ZPD (Gutiérrez, Baquedano-López, Alvarez, & Chiu, 1999; Oliver, Omari, & Herrington, 1998; Richard-Amato, 1996; Rowell, 2002; Vygotsky, 1978). Thus, collaborative L2 learning is oriented toward negotiation and traversing the ZPD (Oxford, 1997);
the participant in the collaborative task plays an active and responsible part in the learning process (Neo, 2003) by employing his or her schema to contribute to the task and to attain the desired output (Ohl, 2001).

Numerous researchers have examined the effects of collaborative learning on learning in general and on L2 language acquisition (e.g., Barnes & Todd, 1977; Bejarano, 1987; Gunderson & Johnson, 1980; McGroarty, 1989; Rowell, 2002; Sharan, 1990; Vandergrift, 1997). In a recent study, Rowell (2002) examined students’ collaborative efforts while building robots. The results indicated that an ebb and flow of participation, collaborative and individual processing strategies, and peer-to-peer tutoring supported learning within the ZPD, as well as the achievement of desired goals, even when pertinent schema were lacking. In an overview of research involving collaborative learning, McGroarty (1989) proposed that group work supports the creative use of students’ L1 in a manner that enhances the development of L2 verbal communication skills and comprehensible output, helps clarify meaning, builds content knowledge, and supports active learning processes. McGroarty and others (e.g., Neves, 1984) further determined that such learning provides a way to use students’ L1 as a bridge rather than a barrier to L2 mastery and that the frequency of talk between peers, even if in the first language, can directly enhance students’ L2 comprehension. Barnes and Todd (1977) examined conversations between students working in small groups in which hesitant and sometimes confusing talk prompted abrupt changes in the ongoing dialogue. This reshaping of the conversation eventually led to the development of new ideas and better understanding of the content. Sharan (1990) and Bejarano (1987) both compared group work to whole class learning and reported that group learning led to higher student motivation, higher student achievement, higher language achievement in terms of grammar and vocabulary learning, and more positive social relations between peers.

Collaborative learning also is consistent with the interactionist perspective on second language acquisition (Chapelle, 1997, 1998; Gass, 1997) that identifies three functions: comprehensible input (Krashen, 1982), some form of interaction (Long, 1985), and comprehensible output (Swain, 1985). In particular, the notion of comprehensible input suggests that learners acquire language best by experiencing material that is just beyond their current level of expertise (Krashen, 1982). Thus, the more comprehensible input learners receive, the more opportunities they have to learn (Fathman & Kessler, 1993).

Numerous researchers, in addition to those mentioned above, have suggested that collaboration or interaction with peers influences comprehensible input (e.g., Chapelle, 1997, 1998; Larsen-Freeman & Long, 1991; Szostek, 1994; Yano et al., 1994). For example, Yano, Long, and Ross (1994) examined the effects of collaboration on text comprehension and discovered that such interactions helped to make the input more comprehensible while maintaining complexity of the linguistic forms present for further L2 acquisition. Szostek (1994) examined Spanish honors students’ output after interacting with one another and noted that group work among the students contributed to enhanced comprehensible input and thus better understanding of the material to which they were exposed.
Collaborative strategies, though crucial for effective classroom learning in general (Devillar & Faltis, 1991), as well as for L2 acquisition (e.g., Enright & McCloskey, 1988; Fathman & Kessler, 1993), are not without pitfalls. Some scholars have indicated that the nature of the task or the software is pivotal for determining the depth of learning when working collaboratively at a computer; when poorly designed or poorly thought-out group activities or materials are employed, learning is less likely (Mohan, 1992; Mydlarski, 1987; Piper, 1986). Renié and Chanier (1995) suggest that if the cognitive differences between peers assigned to groups are too great, harmful effects on the learning process can occur, in particular if the emphasis is on the correct response without consideration of the collaborative learning experience. Hoyles, Healy, and Pozzi (1994) examined student groups as they undertook math tasks at a computer. Collaborative computer work was successful only if the groups had well structured experiences with the material. However, if a group was not balanced but, rather, dominated by directors or navigators, success was possible only if the students already had previous knowledge. In short, success depended on a balance of student interdependence and autonomy.

To achieve understanding and to develop comprehensible input, a relationship must be established between cognitive and social factors that is enhanced by the “artifacts, activities, participants, and interactions within a cultural setting” (Farquhar, McGinty, & Kotcho, 1996, p. 212). When teachers effectively incorporate interactive activities into their courses, learning increases (Devillar & Faltis, 1991). Students learn when they collaborate with others (Ewing, Dowling, & Coutts, 1998) because they take on a more active role in the process, become resources of information for each other (Fathman & Kessler, 1993), and both encourage and support each other in their work (Johnson & Johnson, 1984).

L2 LEARNING AND COLLABORATION WITH MULTIMEDIA

Multimedia approaches to instruction use words (e.g., printed or spoken material) and pictures (e.g., diagrams, graphs, photos, maps, animation, or video) to “provide meaningful input, facilitate meaningful interaction with the target language, and elicit meaningful output” (Plass & Jones, 2005, p. 476). In such an environment, interaction with annotations in the form of text and pictures can lead to more comprehensible input and, thus, greater incidental vocabulary learning (Kost, Fost, & Lenzini, 1999; Watanabe, 1997). For example, Plass, Chun, Mayer, and Leutner (1998) observed that when students accessed both pictorial and written annotations as they read a multimedia-based German text, performance was better for a written vocabulary production test than when only one annotation type was accessed. Yoshii and Flaitz (2002) studied how annotations, such as text, pictures, and a combination of both modalities, in a multimedia-based reading comprehension activity affected ESL students’ vocabulary learning. They discovered that definitions for keywords in both a written and pictorial form led to better vocabulary learning than did definitions for keywords in a single mode. With both pictorial and written annotations present, students could build referential connections between the two systems resulting in a redundancy of information, multiple
retrieval routes to the information, and enhanced vocabulary recall and recognition (Mayer, 2001).

The use of annotations as an interactive processing strategy has also been applied in multimedia learning environments to examine how the availability of pictorial and written annotations for vocabulary items facilitates L2 listening and reading comprehension (Chun & Plass, 1996a, 1996b; Jones & Plass, 2002; Plass et al., 1998; Plass, Chun, Mayer, & Leutner, 2003). In an investigation of a computer-based reading activity, visual and verbal information helped to support macrolevel processing and, thus, greater comprehension of the written material (Chun & Plass, 1996b). Jones and Plass (2002) provided students with varying access to pictorial and written annotations for vocabulary in an aural text based within a multimedia environment. Listening comprehension was greatest when students accessed both written and pictorial annotations.

Other research has shown that the combination of collaborative learning and computers contributes to more comprehensible input and increases the likelihood of understanding within a CMC environment (Hudson & Bruckman, 2002; Kern, 1995; Warschauer, 1997). This, however, entails collaboration through written, as opposed to spoken language. Wells and Chang-Wells (1992) suggest that writing makes collaboration a visual and reflective process, a “cognitive amplifier” that allows a reader to “boot-strap his or her own thinking in a more powerful manner than is normally possible in speech” (p. 122). This sort of text mediation—an approach that includes interaction, reflection, critical thinking, and problem solving (Warschauer, 1997)—allows students to traverse the ZPD, that is, generate new meaning (Wertsch & Bivens, 1992), so as to develop different insights that can be revisited and critically examined for the construction of one’s own understanding of the material (Wells & Chang-Wells, 1992).

In his examination of the amount of language produced in the traditional (aural) classroom setting versus the more innovative use of discussion through networked computers, Kern (1995) collected data showing that CMC promotes interaction within the foreign language classroom setting at a much greater rate than is seen in the “computerless” learning environment. All students participated in the discussion and averaged more messages each when communicating via computers than in the traditional classroom. The students presumably experienced less evaluation apprehension when using the computer, which boosted their confidence and fostered greater acquisition of knowledge; students were not as afraid to make errors when interacting with classmates via the computer program than when they were interacting face-to-face with their peers and teacher in the classroom setting. Hudson and Bruckman (2002) expanded on Kern’s (1995) study by examining how an online CMC environment entitled “IRC Français” can disinhibit learners and, hence, lend credibility to the language ego permeability theory and its emphasis on the deleterious effects of inhibition in language learning. According to Hudson and Bruckman (2002), adults become inhibited when learning a language because they feel inferior without the same command or grasp of the L2 as with the L1; the fear of making mistakes increases, and comfort in speaking an L2 is less likely. Though the quantitative findings showed enhancing effects of CMC on students’
language use, qualitative data further demonstrated that communicating with others in an online environment was more supportive, more community oriented, and less inhibiting.

Since language learning can be influenced by social and interpersonal factors, it makes sense to consider social interaction as an important aspect of multimedia learning as well (Renié & Chanier, 1995). Crook (1994) focused on the importance of social interactivity in learning and challenged the descriptors for how we interact and use computers simultaneously. He specifically clarifies the differences between interaction with, in relation to, at, around, and through computers and describes how related interactive strategies can enhance learning. For example, in its basic design, interaction with computers is a process in which a human points and clicks with the mouse. The computer responds by completing the task programmed for that particular click. In such cases, students interact with the computer as though it were another person, a form of face-to-face interaction. However, interaction at computers involves students collaborating and interacting together at and with the computer to reach a common goal or to solve a problem. Students work in pairs with a single computer while the teacher observes their interactions and provides support and feedback as needed.

Although numerous empirical studies have demonstrated the positive effects of working in a collaborative computer-based environment in other disciplines (e.g., Looi & Ang, 2000; Oliver, Omari, & Herrington, 1998; Slavin, 1995), only a little, but nonetheless important, research has been published in relation to the L2 learning environment (e.g., Bueno & Nelson, 1993; Chang & Smith, 1991; Meskill, 1993; Sparks & Simonson, 2000; Wyatt, 1984). Bueno and Smith (1993) examined how interaction between peers at a computer that provided an aural and written simulated visit to Salamanca would affect language learning and the level of comprehensible input. Students’ collaborative language-learning strategies, such as group negotiation and clarification of meaning, enhanced their comprehensible input as measured in Spanish interviews and writing samples. Chang and Smith (1991) examined how a Spanish CALL/IVD activity used in a group setting might influence students’ output. In the experimental group, students completed all computer-based lessons with an assigned partner; in the control group, students worked alone. L2 learning in an interactive environment that included computer-assisted instruction positively affected students’ achievement and attitude. The mean overall comprehension scores did not differ between the two groups, and closer analysis of explicit and implicit test items revealed no differences among the groups with explicit questions since the answers were clearly stated in the videodisc. However, with implicit questions, students had to provide answers based on their retrospective understanding of the story. The results showed that the paired group outperformed the control group with implicit questions.

Research has shown that in isolation, collaborative strategies and multimedia can enhance L2 learning. However, it has not yet provided evidence of how a multimedia-based listening comprehension activity that includes peer-to-peer collaboration might influence incidental vocabulary learning and recall of aural
material in a L2 environment. The following study, therefore, focused on how multimedia-based pictorial and written annotations and collaborative learning affect students’ performance on an incidental vocabulary learning test requiring them both to recall and recognize vocabulary, as well as on a recall protocol test involving recall, in English, of an aural passage. There were two hypotheses:

1. Students who complete a listening comprehension activity that provides both peer-to-peer collaboration at a computer and access to annotated information will recall and recognize more vocabulary words in a listening passage than those who complete listening tasks without annotated information or without a collaboration partner.
2. Students who complete a listening comprehension activity that provides both peer-to-peer collaboration at a computer and access to annotated information will recall more propositions from a listening passage than those who complete listening tasks without annotated information or without a collaboration partner.

THE STUDY

Method

Participants

The participants were 68 second-semester beginning French students enrolled at the University of Arkansas in Fall 2002. All students, fluent in English and nonnative speakers of French, voluntarily participated in this activity during their regular class time. The students were randomly assigned to one of four groups: control group, collaboration group, annotations group, and annotations + collaboration group. Prior to completion of the listening comprehension activity, all students took a 25-item pretreatment vocabulary recognition test to determine their knowledge of the vocabulary in this study. All students had low prior knowledge of the vocabulary, with an average score of 5.3, with a maximum score of 25, \( M = 5.32, SD = 4.01 \). For these pretest results, which were based on random assignment to the four groups of this study, a 2 x 2 factorial analysis of variance (ANOVA) revealed that the groups did not differ significantly: control group \( n = 15, M = 4.53, SD = 3.09 \); collaboration group \( n = 16, M = 6.63, SD = 4.30 \); annotations group \( n = 19, M = 4.68, SD = 4.20 \); annotations and collaboration group \( n = 18, M = 5.50, SD = 4.23 \).¹

Materials and Apparatus

Two aural multimedia treatments, developed with the aid of Adobe Premiere 4.2 (Adobe, 1994) and Authorware 4.0 (Macromedia, 1997), were presented to students in a 24-station Macintosh computer lab, arranged so that they could only view their own computer screen when working either alone or in pairs. The two multimedia treatments were identical in the following respect: The opening screen explained how to use the program and provided a text-based advance organizer that placed the aural passage in its historical context. This advance organizer
helped students tap into their schema and, thus, better process the upcoming input (e.g., Herron, 1994) by providing information concerning the date and location of the event, as well as the names of the key players involved. Five separate listening comprehension screens followed the opening screen. For each, students clicked on audio buttons to listen to segments of the 2 minutes and 20 seconds narration of an historic encounter as written in 1682 (Buzhardt & Hawthorne, 1993; see text in Appendix A). Twenty-seven keywords, chosen by two French instructors for their importance in understanding the key events of the story, were placed in order of appearance throughout the five computer screens. These keywords—a mixture of nouns, verbs, and adjectives—were placed on the left side of each screen and were accompanied by dots to emulate the flow of the narration between the keywords. A speaker icon appeared in the upper right section of each screen. Students could drag a keyword to this icon to hear its pronunciation.

The two multimedia treatments differed as follows: The control treatment provided no access to annotated information, except for the option to listen to the pronunciation of the 27 keywords visible on the computer screens. No other information was available. Two different groups were exposed to this control treatment: a control group that did individual work (-annos/-collab) and a collaboration group with students paired with a peer (-annos/+collab).

In the pictorial and written annotations multimedia treatment, both a camera and a book icon appeared next to the speaker icon on each listening comprehension screen. Students could drag any of the 27 keywords to the camera and/or the book icon to see their written English translation or their pictorial representation (see Figure 1).

Figure 1
Screen 2 of the +annos/-collab and +annos/+collab Treatment Groups, with Access to Both Pictorial and Written Annotations
Students could select any keyword and its pictorial or written annotation in this treatment at any time before, during, or after each aural segment. Two different groups experienced this treatment: one in which members worked alone (+annos/-collab) and another whose members worked in pairs (+annos/+collab). Thus, within the four multimedia treatment groups, annotations were either present or absent, and collaboration was either present or absent (see Figure 2).

Figure 2
2 x 2 Factorial Design Showing the Presence and Absence of Annotations and Collaboration as Assigned to the Four Groups

<table>
<thead>
<tr>
<th>Annotations</th>
<th>Absent</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>-annos/-collab</td>
<td>+annos/-collab</td>
</tr>
<tr>
<td>Present</td>
<td>-annos/+collab</td>
<td>+annos/+collab</td>
</tr>
</tbody>
</table>

The written annotations, English translations of the French keywords, were in bold-face, 14-point Helvetica font. The pictorial annotations, 14 color drawings and 13 color photos, were pictorial representations of the same French keywords. The pictures had been selected on the basis of a pilot study conducted in the summer of 1999 and have been used in three previous studies (Jones, 2003, 2004; Jones & Plass, 2002).

Dependent Measures and Scoring

The two dependent variables of interest in assessing the effects of the presence or absence of annotations and the presence or absence of collaboration were students’ L2 incidental vocabulary learning and their recall of the aural passage. The first dependent measure, a split multiple-choice vocabulary test, consisted of 26 of the 27 French keywords on the five listening comprehension screens for each treatment. The first 13 items of this test (which involved 10 nouns, 2 adjectives, and 1 verb) comprised the written vocabulary recall segment, which required the students to provide the English translations from memory. The second half of the test, the written vocabulary recognition segment, was identical in style to the pre-treatment vocabulary recognition test and consisted of the 13 remaining keywords (8 nouns, 3 adjectives, and 2 verbs). In this segment of the posttest, five incorrect
English responses, in addition to the correct English response, were provided for each keyword to reduce the potential for students to guess the correct response. The maximum score for the vocabulary test was 26. Its internal consistency, as indexed by the split-half reliability method, was .80.

The second dependent measure, a recall protocol posttest, required students to summarize the aural passage in English. A recall test in English was used since the goal was not to measure L2 production competency but rather L2 comprehension, a method used successfully in related studies (e.g., Chun & Plass, 1996b; Jones & Plass, 2002). Two French instructors collaborated to identify the 63 propositions of the text on the basis of concrete elements present within each sentence, not simply on a sentence-by-sentence basis. Thus, in a sentence such as *Ils revinrent 6 sans armes avec le calumet de paix faisant signe qu’on vienne à leurs habitations*, four propositions were identified: (a) *Ils revinrent*, (b) *6 sans armes*, (c) *avec le calumet de paix*, and (d) *faisant signe qu’on vienne à leurs habitations*. Each individual proposition was worth one point and could only be counted one time. The maximum score for this test was 63. Interrater reliability, defined as the percentage of agreement, was .96. Data collection for the dependent measures occurred immediately after the treatment and again three weeks later.

**Procedures**

A pretest/posttest control group design was used to determine the effects of the absence or presence of annotations and the absence or presence of collaboration on students’ L2 vocabulary learning and listening comprehension for the aural passage. All activities took place during three separate class periods of the students’ normally scheduled French class. During the first class period, students had 8 minutes to complete the written vocabulary recognition pretest. Two days later, each participant was randomly assigned to one of four groups: the control group (-annos/-collab), the collaboration group (-annos/+collab), the annotations group (+annos/-collab), or the annotations and collaboration group (+annos/+collab). Students assigned to a group without collaboration (with or without annotations) worked individually at a computer with headphones. Students assigned to a group with collaboration (with or without annotations) worked in pairs at a single computer with headphones for both individuals. The students had one blank sheet of paper per computer and were to write notes either to themselves, if working alone, or to themselves and their partners as they listened to the aural passage. They then had 14 minutes to listen to the passage, to interact with any available annotated information, and to write notes to themselves or to their partner. Afterwards, they had 8 minutes to summarize the passage in English, without any help from peers or from notes and then another 8 minutes to complete the written vocabulary recognition and recall posttest, again without help from peers or notes. Three weeks later, without additional experience with the aural passage or prior warning, students completed delayed vocabulary and listening comprehension tests. The tests and the amount of time provided to complete them were identical to the previous tests and timing procedures used 3 weeks earlier.
Results

Immediate Written Vocabulary Recognition and Recall Posttest

A 2 x 2 factorial analysis of variance (ANOVA), with the presence or absence of annotations and collaboration as the between subjects variables and with the number of correct answers on the immediate written vocabulary recognition and recall posttest as the dependent measures, yielded the following results. For the immediate written vocabulary recognition and recall posttest there was a statistically significant main effect for annotations $F(1, 64) = 72.75$, $MSE = 1010.1$, $p < 0.001$, $\eta^2 = 0.532$. Main effects for collaboration were not statistically significant $F(1, 64) = 0.00$, $MSE = 0.00$, $p < 1.000$, $\eta^2 = 0.000$, nor was an interaction effect present between collaboration and annotations $F(1, 64) = 0.241$, $MSE = 3.34$, $p < 0.625$, $\eta^2 = 0.004$. Mean scores revealed that those groups with access to annotations outperformed those without access to annotations (see Table 1).

Delayed Written Vocabulary Recognition and Recall Posttest Results

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as between subjects variables and the number of correct answers on the delayed written vocabulary recognition and recall posttest as the dependent measure, revealed a statistically significant main effect for annotations $F(1, 53) = 19.19$, $MSE = 285.74$, $p < 0.001$, $\eta^2 = 0.266$. The main effect for collaboration was not significant $F(1, 53) = 0.529$, $MSE = 7.87$, $p < 0.470$, $\eta^2 = 0.010$, nor was an interaction effect present between collaboration and annotations $F(1, 53) = 0.009$, $MSE = 0.134$, $p < 0.925$, $\eta^2 = 0.000$. Due to attrition, the number of participants in this and all delayed posttests was 57, with $n = 13$ for the -annos/-collab group, $n = 11$ for the -annos/+collab group, $n = 17$ for the +annos/-collab group, and $n = 16$ for the +annos/+collab group. Mean scores revealed that those groups with annotations present outperformed those groups without access to annotations (see Table 1).

Table 1
Results of the Immediate and Delayed Vocabulary Recognition and Recall Posttests by Treatment Conditions

<table>
<thead>
<tr>
<th></th>
<th>Immediate vocabulary recognition and recall posttest</th>
<th>Delayed vocabulary recognition and recall posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>-annos/-collab</td>
<td>7.60</td>
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<td>-annos/+collab</td>
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<td>+annos/-collab</td>
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<td>5.28</td>
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<tr>
<td>+annos/+collab</td>
<td>15.61</td>
<td>2.87</td>
</tr>
</tbody>
</table>
Recall Segment of the Immediate Written Vocabulary Recognition and Recall Posttest Results

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct answers on the recall segment of the immediate written vocabulary recognition and recall posttest as the dependent measure, revealed a significant main effect for annotations $F(1, 64) = 59.70, MSE = 262.40, p < 0.001, \eta^2 = 0.483$. The main effect for collaboration was not significant $F(1, 64) = 0.214, MSE = 0.941, p < 0.645, \eta^2 = 0.003$, nor was an interaction effect present between collaboration and annotations $F(1, 64) = 0.570, MSE = 2.50, p < 0.453, \eta^2 = 0.009$. Mean scores revealed that groups with annotations present outperformed those groups without access to annotations (see Table 2).

Recall Segment of the Delayed Written Vocabulary Recognition and Recall Posttest Results

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct answers on the recall segment of the delayed written vocabulary recognition and recall posttest as the dependent measure, revealed a statistically significant main effect for annotations $F(1, 53) = 13.42, MSE = 45.52, p < 0.001, \eta^2 = 0.202$. The main effect for collaboration was not significant $F(1, 53) = 0.039, MSE = 0.132, p < 0.844, \eta^2 = 0.001$, nor was an interaction effect present between collaboration and annotations $F(1, 53) = 0.363, MSE = 1.129, p < 0.550, \eta^2 = 0.007$. Mean scores revealed that groups with annotations present outperformed groups without access to annotations (see Table 2).

Table 2
Results of the Recall Segment of the Immediate and Delayed Vocabulary Recognition and Recall Posttests by Treatment Conditions

<table>
<thead>
<tr>
<th></th>
<th>Recall segment of the immediate vocabulary recognition and recall posttest</th>
<th>Recall segment of the delayed vocabulary recognition and recall posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>-annos/-collab</td>
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<tr>
<td>+annos/+collab</td>
<td>6.00</td>
<td>2.06</td>
</tr>
</tbody>
</table>

Recognition Segment of the Immediate Written Vocabulary Recognition and Recall Posttest Results

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct answers...
on the recognition segment of the immediate written vocabulary recognition and recall posttest as the dependent measure, revealed a statistically significant main effect for annotations $F(1, 64) = 47.36$, $MSE = 242.82$, $p < 0.001$, $\eta^2 = 0.425$. The main effect for collaboration was not significant $F(1, 64) = 0.184$, $MSE = 0.941$, $p < 0.670$, $\eta^2 = 0.003$, nor was an interaction effect present between collaboration and annotations $F(1, 64) = 0.012$, $MSE = 6.070E-02$, $p < 0.914$, $\eta^2 = 0.000$. Mean scores revealed that those groups with annotations present outperformed those groups without access to annotations (see Table 3).

**Recognition Segment of the Delayed Written Vocabulary Recognition and Recall Posttest Results**

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct answers on the recognition segment of the delayed written vocabulary recognition and recall posttest as the dependent measure, revealed a statistically significant main effect for annotations $F(1, 53) = 17.86$, $MSE = 128.142$, $p < 0.001$, $\eta^2 = 0.252$. The main effect for collaboration was not significant $F(1, 53) = 0.510$, $MSE = 3.66$, $p < 0.478$, $\eta^2 = 0.010$, nor was an interaction effect present between collaboration and annotations $F(1, 53) = 0.017$, $MSE = 0.124$, $p < 0.896$, $\eta^2 = 0.000$. Mean scores revealed that those groups with annotations present outperformed those groups without access to annotations (see Table 3).

**Table 3**

Results of the Recognition Segment of the Immediate and Delayed Vocabulary Recognition and Recall Posttests by Treatment Conditions

<table>
<thead>
<tr>
<th>Treatment Conditions</th>
<th>Recognition segment of the immediate vocabulary recognition and recall posttest</th>
<th>Recognition segment of the delayed vocabulary recognition and recall posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>-annos/-collab</td>
<td>5.93</td>
<td>2.63</td>
</tr>
<tr>
<td>-annos/+collab</td>
<td>5.87</td>
<td>1.93</td>
</tr>
<tr>
<td>+annos/-collab</td>
<td>9.79</td>
<td>2.52</td>
</tr>
<tr>
<td>+annos/+collab</td>
<td>9.61</td>
<td>1.88</td>
</tr>
</tbody>
</table>

Overall, when multimedia annotations were present, vocabulary learning in terms of both recall and recognition was significantly greater than when annotations were absent. Collaboration did not have a significant effect on vocabulary learning.

**Immediate Recall Protocol Posttest Results**

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct propositions on the immediate recall protocol posttest as the dependent measure, revealed statistically significant main effects for annotations $F(1, 64) = 78.87$, $MSE$
= 1135.05, $p < 0.001$, $\eta^2 = 0.552$ and for collaboration $F(1, 64) = 7.425$, $MSE = 106.85$, $p < 0.008$, $\eta^2 = 0.104$. There was no statistically significant interaction effect present for collaboration and annotations $F(1, 64) = 1.25$, $MSE = 18.000$, $p < 0.268$, $\eta^2 = 0.019$. Mean scores revealed that those students with access to both annotations and collaboration outperformed those groups without access to both factors (see Table 4). Those with access to annotations once again outperformed those without access to annotations.

**Delayed Written Recall Protocol Posttest Results**

A 2 x 2 factorial ANOVA, with the presence or absence of annotations and collaboration as the between subjects variables and the number of correct answers on the delayed recall protocol posttest as the dependent measure, revealed a statistically significant main effect for annotations $F(1, 53) = 19.243$, $MSE = 305.058$, $p < 0.001$, $\eta^2 = 0.266$. The main effect for collaboration was not significant $F(1, 53) = 2.33$, $MSE = 36.945$, $p < 0.113$, $\eta^2 = 0.042$, nor was an interaction effect present between annotations and collaboration $F(1, 53) = 0.105$, $MSE = 1.669$, $p < 0.747$, $\eta^2 = 0.002$. Mean scores revealed that those groups with access to annotations outperformed those without access to annotations (see Table 4).

<table>
<thead>
<tr>
<th></th>
<th>Immediate recall protocol posttest</th>
<th>Delayed recall protocol posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>-annos/-collab</td>
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<td>3.09</td>
</tr>
<tr>
<td>-annos/+collab</td>
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<td>11.11</td>
<td>4.82</td>
</tr>
<tr>
<td>+annos/+collab</td>
<td>14.56</td>
<td>3.34</td>
</tr>
</tbody>
</table>

A tracking record of annotations selected within the +annos/-collab and the +annos/+collab group revealed that of all annotations accessed, the students selected pictorial annotations 40% of the time and written annotations 60% of the time. In terms of averages, the +annos/-collab group accessed an average of 17 pictorial annotations and 24.6 written annotations per computer while the +annos/+collab group accessed an average of 21.3 pictorial annotations and 30.7 written annotations per computer.

In summary, when both collaboration and annotations were present, students immediately and significantly outperformed those who did not have access to both factors on the recall protocol posttest. Overall, when annotations were present, comprehension was significantly greater than when annotations were absent.

**DISCUSSION**

Hypothesis 1 stated that students who complete a listening comprehension activ-
ity while collaborating at the computer with a peer and with access to annotated information would recall and recognize more vocabulary words of a listening passage than those who complete listening tasks without annotated information or without a collaboration partner.

With regard to this first hypothesis, an examination of effect sizes revealed that annotations had a significant effect on students’ vocabulary learning, while collaboration had no effect. Students either recognized or recalled vocabulary best when written and pictorial annotations were present, regardless of the presence or absence of collaboration. However, when annotations were absent, learning was significantly lower. Thus, the first hypothesis was not supported. Access to both pictorial and written annotations provided students with multiple retrieval routes to the material so as to process helpful, redundant information and thus better recall and identify vocabulary, a result similar to that found in previous research (Chang & Smith, 1991; Jones, 2004). For example, Chang and Smith (1991) discovered no differences between the test results of students who worked alone and those who worked in groups when they responded to explicit questions with answers clearly stated in the videodisc. In the present study, even when examining learning strategies based on recall or recognition of the vocabulary, no significant differences were found between those who accessed annotations, either alone or with a peer. The answers needed to complete the vocabulary test were available in the annotated information and students apparently did not need to collaborate to process this information effectively.

Hypothesis 2 stated that students who complete a listening comprehension activity while collaborating at the computer with a peer and with access to annotated information will recall more propositions from a listening passage than those who complete listening tasks without annotated information or without a collaboration partner.

In regard to this second hypothesis, students performed significantly better on the immediate recall protocol test when both collaboration and annotated information were present. Having a partner with whom to interact in written form offered students an environment in which they could compare their understanding of the material (Blaye, Light, & Rubtsov, 1992), allowed for greater depth of understanding through interaction and negotiation of meaning (Mydlarski, 1998), and enhanced both recall of the aural material and thus comprehensible input (Szostek, 1994). Chang and Smith (1991) observed similar results when students had to provide retrospective responses to implicit questions; students who were paired together could delve more deeply into the material and thus outperformed those who worked alone on the recall protocol. The difficult nature of the aural material in the present study presumably demanded deeper processing to decipher the aural passage in a top-down manner. Accessing annotations while collaborating with a partner may have allowed students to build bridges between words, hypothesize about the aural passage, and subsequently attain significantly greater understanding of the aural passage than when collaboration was absent. In addition, although students in both the +annos/-collab and the +annos/+collab groups accessed an equal amount of annotations based on percentages of all annotations
accessed, the +annos/+collab group averaged more annotations per computer than did those in the +annos/-collab group. Collaboration may well have motivated students to examine the material more closely and to refer to the annotations more often to help clarify meaning as a collaborative unit rather than as individuals.

Aside from the statistical analyses, students’ note-taking revealed that they actively processed information, even though their strategies varied according to the availability of annotations and collaboration (see sample student notes in Appendix B). Within the -annos/-collab group, students wrote few notes and typically recorded the words they believed they understood. This group also made more metacognitive comments than did other groups, which revealed their inability to understand the material adequately. Within the -annos/+collab group, students often exchanged notes, presumably in seeking clarification. This group attempted to understand the passage but still exhibited numerous comprehension errors much like their counterparts in the -annos/-collab group. Without access to annotated information, they could not discern their misinterpretations, nor could they compensate for the difficult nature of the material even through collaboration: “Simply expending more effort does not guarantee increased achievement when learners are unable to create a coherent mental model of the content” (Cennamo 1993, p. 39).

Students with access to annotations produced more notes than those without access to annotations. The +annos/-collab group most often wrote down the French keywords with their English translations and tried to organize the aural passage as they processed each individual screen. These students also attempted to fill in the blanks or build bridges between keywords. The +annos/+collab group utilized these same strategies but also shared their understanding of the material with their peers, supplied missing words requested by their partners, or answered their questions. In one exchange involving two students, Student A began: “They offered pipe to” and Student B responded: “LaSalle.” Student A added: “Now the warriors assembled in the plaza” and Student B responded: “and gave them decorated poles?” Thus, some students in this group communicated in this manner while others summarized their understanding of the material for their partner. Annotations, in conjunction with collaboration, helped this group to establish bridges between keywords and more deeply process the aural input.

Overall, the -annos/-collab and the -annos/+collab groups performed the poorest; the difficult aural text and the absence of annotated information prevented them from building contextual knowledge (Cennamo, 1993; Hulstijn, 1992; Jones, 2003; Jones & Plass, 2002) and lessened their ability to incidentally learn vocabulary and recall the aural passage. Conversely, a multimedia effect (Mayer, 2001) demonstrated that L2 vocabulary acquisition and aural comprehension was consistently strong when students had access to annotated information. Students could look up words more than once and in different modalities to support inferencing and verification strategies (Grace, 1998), and to reinforce what they had learned (Chun & Plass, 1996a, 1996b). Additionally, lower level processing—word recognition—was not supported by collaborative learning but was instead supported by the multimedia effect. However, higher macrolevel processing that
involves understanding of propositional units and the integration of new input with prior knowledge was affected both by collaborative learning and by the multimedia effect (Devitt, 1997).

CONCLUSION

This study adds to the growing body of literature relating to the benefits of annotations for L2 vocabulary learning and listening comprehension. According to Mayer’s (2001) cognitive theory of multimedia learning, the ability to review information more than once allows for multiple retrieval routes to the information and reinforces students’ learning (Chun & Plass, 1996a, 1996b). Since students rely on different modalities to learn efficiently in different ways (Plass et al., 1998; Reinert, 1976), providing them with an opportunity to choose the mode of information they prefer may help them better learn the vocabulary and comprehend the aural material presented. L2 multimedia environments that provide pictorial and written modes of information may be most effective for L2 learning because students can choose the mode that best suits their needs and preferences (Plass et al., 1998).

This study also suggests that providing both collaboration and interactive multimedia in a single learning environment can enhance students’ listening comprehension and support their vocabulary learning. The ability to interact with the computer and collaborate with peers at a computer reinforces learning (Crook, 1994), and supports the notion of progression through the ZPD (Vygotsky, 1978). Hence, L2 multimedia environments that provide pictorial and written modes of information and allow for collaborative discussion of the material experienced may be most effective for L2 learning because students can clarify meaning, test their hypotheses, and support each others’ information processing. Although both groups that accessed annotated information never differed significantly in their performance on the vocabulary test, this should not devalue the importance of collaboration since learning at a computer did not diminish when students worked in pairs. Indeed, working collaboratively with multimedia annotations proved to be just as effective, if not better, as working alone. Schools that cannot provide enough computers for each student in a single class can rest assured that the placement of two students per computer can be educationally sound, cognitively supportive, and cost effective (Mydlarski, 1998).

Collaboration in students’ native language also supported their L2 comprehension (McGroarty, 1989) and helped to develop comprehensible input (Krashen, 1982). The students utilized their prior knowledge, their learning abilities, their motivation to learn, and their native language, while the computer offered them multiple ways to process the input and to make it more comprehensible. The students approached the problem with multiple voices present and developed a sense of shared knowledge that supported their learning and development. Therefore, if we can utilize L2 applications that help students interact with the computer but develop new meanings and understandings through interaction at the computer, then we may better guide students to their potential development level through their ZPD.
Future research needs to focus on issues related to the outcomes of this study. First, an approach that more thoroughly examines the connection between collaboration, annotated information, and selection of annotation type seems warranted. Previous studies have shown that processing pictorial or written annotations alone can sometimes be just as effective as processing both annotation types (e.g., Jones, 2004; Jones & Plass, 2002). Thus, to what extent will collaboration interact with pictorial or written annotations alone and how will these interactions affect comprehension and vocabulary learning? Such a study in conjunction with an analysis of students’ spatial and verbal abilities might possibly better clarify the extent to which ability type and collaboration interact with annotations and affect learning. Second, an approach that examines collaboration in an aural rather than a written mode should be studied. Since only written notes were allowed, so as to reduce distractions within the lab environment, a strategy that includes aural communication could potentially lead to richer, more natural discussion and thus greater comprehension and vocabulary learning. Third, though comprehensible output is not addressed in this particular study, future research should also examine how we can use both the power of multimedia and the power of collaborative learning to positively enhance students’ comprehensible output.

NOTES

1 One vocabulary word “la place,” later included in the vocabulary recognition and recall posttests, was inadvertently omitted from the pretreatment vocabulary test. Hypothetical statistical analyses revealed that this omission did not have an effect on the differences among the four groups.

2 One key phrase presentèrent à fumer was purposefully omitted from the posttests both to maintain an equal balance of 13 vocabulary items per vocabulary test segment but also to avoid redundancy since the related keyword fument was included in the vocabulary test.

3 Because of the presence of attrition, a statistical examination of results in which only students who completed both the immediate and delayed tests was undertaken. Outcomes were the same in terms of the presence or absence of statistically significant differences. However, because the groups in the immediate posttests were not as balanced when attrition was taken into account, only the more balanced group outcomes for the immediate posttests (N = 68) with the outcomes based on attrition for the delayed posttests (N = 57) are reported.

REFERENCES


Linda C. Jones


APPENDIX A

Text of Listening Comprehension Passage

LaSalle Meets the Quapaws (1682)

On fit traverser les canots sur la gauche à une pointe de sable. On se retranche le mieux que l’on peut avec des petits bois de tremble, qu’on coupa, dont on fit des palissades. La brume se cessa, et l’on vit un canot de Sauvages venir à nous …. Mais voyant qu’on ne leur en tirait point, ils s’en retournèrent chercher dire que c’étaient des gens de paix. Ils revinrent 6 sans armes avec le calumet de paix faisant signe qu’on vienne à leurs habitations. Ils présentèrent à fumer à M. de LaSalle et à tous ceux qui étaient autour de lui disant toujours qu’on s’embarque …. Le lendemain les guerriers et la jeunesse dansèrent le calumet. C’est de s’assembler tous sur la place. Les guerriers mettent leur présents sur des perches comme quand on veut faire sécher du linge. Ils apportent deux grands calumets enjolivés de plumes de toutes couleurs et pleins de cheveux de leurs ennemis. Ils mettent tout cela entre les mains de leurs chefs qui sont assis sur leurs culs et arrangés autour de la place. Ils ont tous des gourdés pleines de cailloux et des tambours qui sont des pots de terre. Ils commencent une chanson qu’ils accompagnent du bruit de leurs instruments. Les guerriers qui ont fait de belles actions vont danser et frapper un poteau avec leurs casse-tête et disent les belles actions qu’ils ont faites … cependant les chefs fument, l’un après l’autre dans les calumets, et chacun le présentait à M. de LaSalle et à tous ceux dans la compagnie. Après, ils le prirent et le placèrent au milieu de la place, dansant tous autour de lui au son des ins-
truments et chansons, chacun lui mettant sur le corps son présent qui étaient des peaux de boeufs qui ont de la laine comme nos moutons d’Europe. Si les Français ne l’avaient pas déchargé à mesure de ses peaux, ils l’auraient étouffé sous leurs présents. Il leur fit à son tour présents de haches, couteaux, et rassades.

APPENDIX B
Examples of notes written by students within each treatment group

-annos/-collab group

<table>
<thead>
<tr>
<th>Example 1:</th>
<th>Example 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>-gave up arms? or six</td>
<td>-I have no idea what is being said</td>
</tr>
<tr>
<td>-drink</td>
<td>-they’re wearing friends coat</td>
</tr>
<tr>
<td>-smoking presented to M. de la Salle</td>
<td>-potatoes</td>
</tr>
<tr>
<td>-the carried 2 ?____</td>
<td>-they start</td>
</tr>
<tr>
<td>-chef smoke?</td>
<td>-rassade is a verb</td>
</tr>
<tr>
<td>-presented M. de la Salle to the company.</td>
<td></td>
</tr>
</tbody>
</table>

-annos/+collab group

Example 1:
Student A
- guerriers → warriors?
- they assembled at the square
- the canoe landed to the left
- s’assemble tous sur → on the place
- took a little drink?
- savage we come
- they return to find someone to talk to in peace?
- I think « la brume » is speaking.
- voyons is nous form
- mes, or mais?
- 6 came w/out arms, with the flag of peace, looking for signs of habitation
- offered a smoke to ? and others with him.

Student B
- paix → peace
- toujours? everywhere?
- mes (voyons), an object, or group of people?
- à Monsieur de la Salle; peace pipe

Example 2:
Student A
- try to find words you understand
- bois = drink
- habiter?
- des peaux de beufs = beef
- étouffé is some kind of food
- I know what fumer means and that’s it

Student B
- moutons = lamb?
- There was something about potatoes
- You get any of that?
Example 1
-pulled the canoes to the left shore into the sand.
it was foggy, we wanted to find our neighbors to make peace.
-they were unarmed and offered us a peace pipe.
-they offered the pipe to M. LaSalle.
-they presented something to M. LaSalle.
-some of the things they presented were buffalo hides, wool and sheep.
-we were preparing to leave, something suffocated, and they gave us hatchets and beads.

Example 2
-les canots – canoes
-sable – sand
-se retraiter – to entrench oneself
-bois – wood
-la brume – fog
-paix – peace
-
-sans armes – unarmed
-le calumet – pipe
-présentèrent à fumer – offered the pipe to
-6 unarmed with the peace pipe...how environment
-
-les guerriers – warriors
-s’assembler – to assemble/gather
-des perches – poles
-enjolivés – decorated
-culs – backsides
-la place – plaza
-warriors assembled in the plaza
-the warriors...poles...home of
-brought decorations of all colors
-beginning in the plaza
-
-des gourdes – gourds
-cailloux – pebbles
-un poteau – post
-casse-tête – club
-fument – smoke
-ils sont tout des gourdes, plein de cailloux...qui sont pots de terre...

+annos/+collab group

Example 1:

Student A
- canoes on sand
- rode canoes up river to sand; they trapped themselves with wood?
- look for peace
- fog was heavy
- 6 unarmed with peacepipe..
- they offered the pipe to??
- now the warriors assembled in the plaza and??
- wore clothes decorated w/all the colors
- they have gourds and pebbles, potatoes.
- they begin to be copain?

Student B

-LaSalle
- and gave them decorated poles?
- and arranged a tour of the plaza
- friend
Example 2:

<table>
<thead>
<tr>
<th>Student A</th>
<th>Student B</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6 unarmed w/pipe</td>
<td>-LaSalle saw canoes by sand and found Indian tribe, unarmed peacepipe</td>
</tr>
<tr>
<td>-they offered the pipe to LaSalle</td>
<td>-the chef smokes, party</td>
</tr>
<tr>
<td>-warriors gathered around pole</td>
<td>-warriors have good action</td>
</tr>
<tr>
<td>-decorated with colors</td>
<td>-decorated w/feathers in hair</td>
</tr>
<tr>
<td>-gourdes and pebbles</td>
<td>-use gourdes and pebbles to make instruments; sing with friends &amp;</td>
</tr>
<tr>
<td>-they began the songs</td>
<td>instruments.</td>
</tr>
<tr>
<td>-dancing</td>
<td>-dancing with him, give him buffalo hides, wool from sheep</td>
</tr>
<tr>
<td>-women</td>
<td></td>
</tr>
</tbody>
</table>

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