Effectiveness of hypermedia annotations for foreign language reading

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Abstract
This study first explores intermediate-level English learners’ preferences for hypermedia annotations while they are engaged in reading a hypermedia text. Second, it examines whether multimedia annotations facilitate reading comprehension in the second language. The participants were 44 adult learners of English as a foreign language studying English for Academic Purposes. Data were collected through a tracking tool, a reading comprehension test, a questionnaire, and interviews. Results indicate that learners preferred visual annotations significantly more than textual and audio annotations. On the other hand, a negative relationship was found between annotation use and reading comprehension. Especially, pronunciations, audiorecordings, and videos were found to affect reading comprehension negatively. However, the qualitative data revealed that the participants had positive attitudes towards annotations and hypermedia reading in general.

Keywords
annotation use, hypermedia, L2 reading

Introduction
Hypermedia refers to computer-based applications that provide information in a nonlinear way through multiple types of resources such as text, graphics, sound, video, and animation (Kommers et al. 1996). It is suggested that hypermedia is potentially useful for second language (L2) reading because a given text can be made comprehensible for L2 readers by annotating it with multiple types of media in the form of glossaries (Davis 1989; Martinez-Lage 1997; Roby 1999). In order to help L2 learners cope with an authentic text, glossaries have been considered more effective than simplifying the text (Widdowson 1984). Thus, glossaries may be utilized to facilitate reading comprehension by providing information both at the word or sentence level and at the topic level.

While annotating L2 texts may be useful in helping learners cope with an authentic text, it also makes text processing more complicated. Current models of L2 reading that emphasize interaction of bottom-up and top-down processes for successful reading comprehension (Bernhardt 1991) fall short in explaining text processing in a hypermedia environment. In this case, the reader is not only engaged in processing the text but also the verbal and visual input that are provided through the annotations.

Mayer (2001) proposes a cognitive theory of multimedia learning to explain how learning from verbal and visual input takes place. The theory, which incorporates Dual Coding Theory and Cognitive Load Theory, is based on three main assumptions. The dual channels assumption suggests that visual and verbal information is processed in separate channels; however, one type of information may be transferred to the other through the interaction between the channels. The limited capacity assumption suggests that each channel has a limited capacity. Finally, active pro-
cessing assumption suggests that humans are actively involved in the construction of knowledge. Thus, when verbal and visual input is provided through a multimedia presentation, the learner selects relevant words and images and organizes them separately into verbal and pictorial models where connections among selected words and images are established to form a coherent mental structure. These two models are qualitatively different in that pictures provide holistic and nonlinear information while words provide discrete information in a linear way. Thus, the two models are supposed to complement each other. Learning takes place when the learner establishes connections between the corresponding portions of the verbal and visual model with the help of prior knowledge, hence integrating these two models in the working memory. Mayer provides empirical evidence supporting his theory and contends that learning in multimedia environments is facilitated when the information is presented through the verbal and visual channels in a way that does not overload the working memory such as presenting information by accompanying words and with pictures instead of only in words, placing words and pictures near rather than far from each other, presenting words and pictures simultaneously instead of successively, and so forth.

While evidence presented by Mayer is based on studies conducted with native speakers of English, few studies have investigated the effectiveness of multimodal information in L2 learning. The research review in the next section focuses on the studies that investigated the impact of multimodal information provided through electronic glosses on L2 reading comprehension.

Review of related literature

Early studies on the effectiveness of electronic glosses compared hyperdictionaries with conventional paper dictionaries (Roby 1991 cited in Roby 1999; Aust et al. 1993). These studies revealed that students tended to consult the hyperdictionary more frequently than traditional dictionaries, while taking less time to read the text. However, neither study found significant differences between the groups in terms of reading comprehension. Such comparisons between traditional and electronic dictionaries may not be meaningful anymore because reading on the computer is becoming widespread. Therefore, we need to investigate the effectiveness of hypermedia dictionaries, addressing issues such as for whom and under what conditions they are effective. Later studies were confined to hypermedia dictionaries and provided insightful information by using tracking technology that recorded participants’ interactions with a given text.

Several studies investigated learners’ preferences regarding the types of annotations (Davis & Lyman-Hager 1997; Lomicka 1998; Chun 2001, Ercetin 2003). Davis and Lyman-Hager found that the 42 intermediate-level French learners had a strong preference for annotations providing first language (L1) translations of words. This finding was confirmed by Lomicka’s small-scale study with 12 French learners, who were also provided with other types of glosses such as images, references, L2 definitions, and questions. Chun and Ercetin investigated learners’ annotation preferences according to proficiency levels. Chun found that low-verbal ability learners used both internal and external dictionaries more than high verbal ability learners. This finding was confirmed by Ercetin, who found that intermediate proficiency students accessed annotations significantly more than advanced students. She also found that both groups accessed word definitions and video annotations that provided further information about the topic more frequently than the other types of annotations such as pronunciations of words, audio recordings, and graphics providing extra information about the topic.

As for the effectiveness of annotations, Davis and Lyman-Hager (1997) did not find any meaningful relationship between annotation use and reading comprehension although students reported positive attitudes towards the annotations. On the other hand, Lomicka (1998) found that full glossing (L1 translation and L2 definitions plus pronunciations, images, references, and questions) was more effective than limited glossing (L1 translation and L2 definitions) or no glossing, in facilitating L2 reading comprehension. However, Lomicka’s findings should be considered with caution because of its small subject size. Another piece of evidence for the effectiveness of glosses for L2 reading comprehension came from an experimental study conducted by Davis (1989), who found that providing definitions of words and comments as glosses during reading was as effective as providing
them before reading, and both techniques were more effective than providing no aids at all.

Knight (1994) investigated the extent to which low- and high-verbal ability learners benefited from annotations by randomly assigning 112 Intermediate-level students of Spanish to dictionary access and no dictionary access conditions. Knight’s study suggested that using a dictionary was more beneficial for low-verbal ability students because the correlation between the frequency of word lookup and reading comprehension was much higher for this group ($r = 0.68$) than the high-verbal ability group ($r = 0.17$). This finding was also confirmed by Chun (2001), who found no difference in the number of propositions recalled between the high and low ability groups, and thus concluded that the latter group benefited more from an external and internal bilingual dictionary. On the other hand, Ariew and Ercetin (in press), in a study with a total of 84 intermediate and advanced learners of English, found a negative correlation between annotation use and reading comprehension for intermediate learners, while no relationship was observed between the two variables for the advanced group. The findings of this study shed doubt on the usefulness of annotations for L2 reading comprehension.

Finally, Chun and Plass (1996), in a series of three studies conducted with 160 university students of German, investigated the effectiveness of particular types of annotations on reading comprehension. They found that presenting words with both visual and verbal annotations facilitated reading comprehension more than words with no annotations or with verbal annotations only.

To sum up, the studies that are available to us have revealed insufficient and inconclusive results about what types of hypermedia annotations learners prefer to use and whether hypermedia annotations facilitate reading comprehension. Thus, this study aims to address these issues. More specifically, the research questions are:

(a) What are the annotation preferences of intermediate-level English as a foreign language (EFL) learners when they are engaged in reading a hypermedia text?

(b) Is there a relationship between the overall amount of annotation use and reading comprehension for intermediate-level EFL learners? If so, in what way do particular types of annotations influence reading comprehension for intermediate-level EFL learners?

It was hypothesized that learners would prefer videos and pictures to access more information about the topic (Ercetin 2003), while word definitions would be preferred to comprehend the meanings of unknown words (Davis & Lyman-Hager 1997; Lomicka 1998). However, no direct relationship was expected between the overall amount of annotation use and reading comprehension (Davis & Lyman-Hager 1997).

**Methodology**

**Participants**

A total of 125 Turkish students studying English for Academic Purposes at a Turkish university were given the Oxford Placement Test (Allan 1992) to determine their proficiency levels in English. This placement test comprises two main sections, a listening test and grammar test, with 100 items in each section. The test provides percentage scores out of 200. For the purposes of this study, the score range between 135 and 145 was considered intermediate level, which is roughly equal to level 5 in the IELTS, FCE, and CCSE, level 2 in Cambridge exams, AP according to ARELS exams, and OP according to Oxford exams. The data for the 44 intermediate-level participants were retained for analysis. Twenty-six of the participants were males and 18 were females. The average age was 20 years, ranging between 18 and 25 years. The participants all had considerable experience with computers and were familiar with language learning CD-ROMs, word processing software, Internet, and e-mail.

**Materials**

The data were collected through a hypermedia reading text, a reading comprehension test, a questionnaire, and interviews.

**Hypermedia reading text**

An authentic online reading text was selected from The National Geographic Journal website (http://www.nationalgeographic.com/greatland/) and was annotated with multiple types of media such as text, graphics, audio, and video by using a reading software
designed by Ariew (1999). The text consisted of 900 words and had a linear organization, where the information was presented in nine consecutive pages successively. A navigation map was provided for the readers showing their location in the document so that they would not get lost. The annotations were conceptually categorized as *textual* and *extratextual* (see Fig. 1).

**Textual annotations** provided information about the text in the form of an internal glossary; the information consisted of definition of a word (text), its pronunciation (sound), and sometimes a picture (graphics) to help understand the meaning of a given word. A total of 104 textual annotations were provided within the body of text; an annotated word or phrase was a part of the text and was indicated by its blue colour (see Fig. 2).

**Extratextual annotations** provided background information about the topic. A total of 26 extratextual annotations were provided below the text and were indicated by coloured buttons placed on the page. When a participant clicked on a background information button, they could see in what forms of media the information was available (i.e., text, graphics, sound, or video) (see Fig. 3).

To ensure that the participants actually viewed the annotations, they were required to hold the left mouse button down after they clicked on a particular annotation. Thus, the amount of time the participants engaged the mouse was considered to be the time they viewed a given annotation.

Participants were able to choose and view as many annotations as provided. Thus, they were allowed to view the same annotation more than once. The software tracked every interaction of the reader with the text, including which annotations the reader chose to view, how much time (in seconds) the reader spent on a particular annotation, the order in which the annotations were selected, and the total amount of time spent on reading the text. The data were saved as a log file. Because the tracking tool was hidden, the collection of the data regarding the participants’ interaction with the text did not hinder the flow of reading.

**Reading task**

There were two separate reading tasks, thus two reading sessions. During the first reading, the subjects were asked to read the text for general comprehension and use the annotations to help them understand the text. They were told that they would be asked to write everything they remembered without looking at the text. This reading session including the recall test took approximately 45 min. During the second reading, the subjects were given a reading comprehension test, of which they were not informed beforehand. This time they were allowed to access the text to answer the questions. The first reading was necessary to make sure that the participants made use of the annotations.
It was thought that if they had been given the comprehension test during the first reading, learners might have used the annotations in a limited way.

Reading comprehension test

Although the participants completed a recall task after the first reading, their recall protocols were not used to measure their reading comprehension because this was a totally new task to them. As indicated above, the goal of the first reading was to ensure the use of glosses. Reading comprehension was measured with a test developed by the researchers. The reading comprehension test contained 20 questions consisting of 15 multiple-choice questions and five open-ended questions, with a maximum possible score of 20. As the goal was to examine whether annotations facilitated comprehension of the text, the questions on the test assessed the important information provided in the text, not in the annotations. The subjects were not informed that the questions would involve information in the main text only. The questions were based on the main ideas and details in the text as identified by a native-speaking teacher of English. The multiple-choice questions elicited specific factual information, whereas the open-ended questions required analysis and synthesis of the information in the text. Both
multiple-choice and open-ended questions had the same weight as one point for each correct answer. Scoring of open-ended questions was carried out entirely based on the content of the answer; students were not penalized for errors of grammar, spelling, or punctuation. The test was given on paper and the reading text was available on the computer to the students during the test.

Questionnaire and interviews

A questionnaire was given after the experiment, with the purpose of obtaining information about the participants’ experience with hypermedia reading and their perceptions of the usefulness of the annotations.

The interviews, which took place the week after the treatment, were conducted with 12 volunteering participants and in their L1. The purpose of the interviews was to collect supplementary data about participants’ use of annotations while reading.

Procedures

The data collection was completed in two phases. The first phase took place in the computer lab and lasted 2 h. After a 10 min demonstration on how to operate the software, the participants were asked to read the text for general comprehension and completed a recall task. Next they were given a reading comprehension test to complete during which they were allowed to have access to the text. For each participant, two log files were saved on the hard disk: one for the participants’ interaction with the text during the first reading, and the other for their second interaction while answering comprehension questions. Immediately after they finished the comprehension test, they started filling in the questionnaire, which was attached to the test. The second phase of data collection involved semi-structured interviews with 12 volunteer participants within 1 week after the experiment.

Table 1. Frequency of access to textual and extratextual annotations

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<th>Textual annotations</th>
<th>Extratextual annotations</th>
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<tr>
<td></td>
<td>Text</td>
<td>Audio</td>
</tr>
<tr>
<td>Reading I</td>
<td>45</td>
<td>30</td>
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<tr>
<td>Reading II</td>
<td>6</td>
<td>1</td>
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<tr>
<td>Number of annotations</td>
<td>102</td>
<td>102</td>
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Results

Learners’ preferences regarding types of annotations

In order to find out what types of annotations the participants preferred, the average of total number of times participants accessed each annotation was calculated for the first and second reading. Table 1 shows the frequency of access to annotations in the first and second reading, and the total number of time annotations occurred in the text.

As the table indicates, participants tended to use the annotations during the first reading that involved general comprehension. The reason for infrequent annotation use during the second reading might be either because the subjects had already seen the annotations or because they felt no need to use them because the answer was found in the main text.

The average of two readings was divided by the total number of times a particular annotation occurred in the software because the frequency of occurrence for each annotation type was different. Because the distribution was not normal, a square-root transformation was applied to the data. Table 2 provides the means and the standard deviations after the data are transformed.

As the table shows, the most frequently accessed annotations were video and graphic annotations, which provided extra information about the topic, and graphic annotations, which illustrated the meanings of words. On the other hand, pronunciations of words and verbal annotations that provided extra information about the topic in the form of text and audio were accessed the least. In order to determine whether differences among the means were significant, a one-way repeated measures ANOVA was conducted. The sphericity assumption of the ANOVA test was checked with Mauchly’s sphericity test. In case of the violation of the sphericity assumption, adjustments were made to the ANOVA results using the Geisser–
Greenhouse epsilon, which provides an $F$-test using a much more stringent criterion. This analysis revealed a significant difference in the frequency of access to different annotations, $F(6258) = 67.04$, $P < 0.01$ (with the Geisser–Greenhouse correction), suggesting that certain types of annotations are preferred significantly more than others (Fig. 4).

The results of the pairwise comparisons with Tukey post hoc tests indicated that pronunciations of words were preferred significantly less and videos were preferred significantly more than all other types of annotations. Insignificant differences are shown with the same sign in Fig 4. Thus, these results partly confirmed the first hypothesis, which stated that the participants would use graphics and video annotations to obtain extra information about the text. However, the hypothesis that word definitions would be used to retrieve the meanings of words was not confirmed because the participants accessed pictures more frequently than definitions.

Effect of overall annotation use on reading comprehension

Annotation use was analysed in terms of the total number of times the participants accessed the annotations and the total amount of time they spent on the annotations. Even though there was a substantial positive relationship between the two variables ($r = 0.70$, $P < 0.001$), it was thought that the frequency of access to annotations did not necessarily reflect the amount of time spent utilizing the annotations. An examination of the correlations of these variables showed that reading comprehension correlated negatively both with the frequency of access to annotations ($r = -0.42$, $P < 0.01$) and the amount of time spent on annotations ($r = -0.43$, $P < 0.01$). This indicates that performance on the reading comprehension test decreased as annotation use increased. Thus, the second hypothesis that there would not be a direct relationship between annotation use and reading comprehension was rejected. The findings suggest that using annotations might have hindered reading comprehension.

Effect of particular annotations on reading comprehension

An examination of the correlations between specific types of annotations and reading comprehension revealed that some annotations had statistically significant correlations with reading comprehension while others did not have any correlations at all. Table 3 provides the correlations between annotation types and reading comprehension.

Statistically significant correlations were found between reading comprehension and pronunciations of words ($r = -0.39$, $P < 0.01$), audio recordings ($r = -0.39$, $P < 0.01$), and videos ($r = -0.37$, $P < 0.05$) providing extra information about the topic. However, these correlations were negative. Other variables had low or negligible correlations with reading comprehension.

A multiple regression analysis was conducted on reading comprehension scores as the dependent variable, with audio and video annotations as the independent variables. Because there was a high

### Table 2. Means and standard deviations for the frequency of access to annotations after the square root transformation

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<th>Textual annotations</th>
<th>Extratextual annotations</th>
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<tr>
<td></td>
<td>Text</td>
<td>Audio</td>
</tr>
<tr>
<td>Mean</td>
<td>0.68</td>
<td>0.28</td>
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<tr>
<td>SD</td>
<td>0.19</td>
<td>0.18</td>
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correlation between textual audio and extratextual audio annotation use \( (r = 1.00, P < 0.001) \), the former was not included in the analysis to avoid multicollinearity among the independent variables. Results indicated that the model was significant \( (F_{2, 41} = 5.00, P < 0.01) \). The two variables together explained 20% of the variability in reading comprehension \( (R^2 = 0.20) \). However, the negative relationship between these variables and reading comprehension may suggest that these annotations hindered reading comprehension instead of enhancing it.

To summarize the quantitative findings, learners preferred visual annotations to help them understand the text. However, these annotations did not necessarily facilitate reading comprehension. On the contrary, certain types of annotations, i.e., audio and video annotations, had a negative impact on reading comprehension.

### Findings from the questionnaire and interviews

Qualitative data were obtained from the questionnaire and interviews to cross-analyse the quantitative findings. The participants were asked to rate the usefulness of annotations for reading comprehension in the questionnaire (Table 4).

There seems to be a consensus among the participants regarding the usefulness of video and graphics annotations because the majority of them rated these annotations as either ‘very useful’ or ‘essential’. Although verbal annotations providing word definitions and extra information about the topic were not rated as highly as video and graphics annotations, they were still considered to be ‘useful’. On the other hand, there does not seem to be a consensus on the usefulness of audio annotations. Thus, the ratings suggest that participants perceived visual annotations to be most vital for text comprehension.

Participants who were interviewed also stated that they preferred the visual annotations to retrieve background information about the topic as suggested by one participant: ‘Because the topic was new to me, the annotations about the topic were very helpful, especially the visual annotations’. Another participant provided a similar response: ‘Visuals and movies themselves told everything about the topic. How am I

<table>
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<th>Table 3. Intercorrelations among the variables for frequency of access to annotations.</th>
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<tr>
<td>1. Reading comprehension</td>
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<tr>
<td>2. Textual text</td>
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<td>3. Textual graphics</td>
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<td>4. Textual audio</td>
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<td>5. Extratextual text</td>
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<td>6. Extratextual graphics</td>
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<td>7. Extratextual audio</td>
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<td>8. Extratextual video</td>
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*\( P < 0.05 \), **\( P < 0.01 \), ***\( P < 0.0001 \)

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<th>Table 4. Usefulness of annotations rated by the participants</th>
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<td>Not at all useful (%)</td>
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<tr>
<td>Annotations that provided information about words</td>
</tr>
<tr>
<td>Text (definition)</td>
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<tr>
<td>Audio (pronunciation)</td>
</tr>
<tr>
<td>Graphics</td>
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<tr>
<td>Annotations that provided extra information about the topic</td>
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<tr>
<td>Text</td>
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<tr>
<td>Audio</td>
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<tr>
<td>Graphics</td>
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<tr>
<td>Video</td>
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supposed to know about an animal I’ve never seen and heard; however, pictures and movies showed me the animal directly much better than the words’. Moreover, the participants especially emphasized that the videos ‘made the text more interesting’ as stated by a participant: ‘I liked and used movies a lot. I watched them to understand the topics without reading the main text. I did the comprehension test using the information from the movies’.

As for the usefulness of annotations providing word definitions, participants indicated that definitions of words allowed them to find the meaning of words easily without slowing the reading pace as stated by one participant: ‘This is very different from traditional reading for language learners. I usually skip the words I don’t understand and never check for their meanings from a dictionary; however, with this text, I can easily check their meaning at a single click. Furthermore, this is more permanent because of double information (pictures and text together)’. On the other hand, another participant stated using such annotations when he could not guess the meaning from context: ‘Pictures helped to understand the meanings in case I couldn’t do that using the context’. Thus, for all of the participants who were interviewed, graphical cues for words were ‘necessary’ or ‘essential’. One participant summarized this groups’ preferences succinctly: ‘I first checked the pictures, secondly the video, then the audio finally the text. I mostly used the annotations that provided information about the topic’.

To sum up, the participants’ perception of the usefulness of annotations was consistent with their actual annotation preferences because the log data also showed that they accessed the visual annotations significantly more frequently and spent significantly more time on these annotations than other types. Interviews revealed that most of the subjects considered visual annotations essential because they were interesting and motivating.

**Discussion**

An examination of the specific types of annotations used by the learners revealed that learners consistently preferred visual information (i.e., graphics and/or videos). These annotations were rated as highly useful by the participants. This finding is similar to Ercetin (2003), who also found that both advanced and intermediate learners preferred visual annotations.

Negative correlations between overall annotation use and reading comprehension may suggest that annotations might have hindered reading comprehension. This finding complies with the findings of Ariew and Ercetin (in press), but is contrary to the findings of Davis (1989) and Lomicka (1998), who found glossing to be more useful than no glossing, and Davis and Lyman-Hager (1997), who found no relationship between annotation use and reading comprehension.

Regarding the effects of specific types of annotations, audio recordings and videos in particular might have distracted readers and interfered with reading comprehension. These findings partially comply with the findings of Ariew and Ercetin (in press), who also found a negative impact of videos on reading comprehension for intermediate learners, whereas no impact was found for advanced learners. Thus, multimedia annotations might have had deleterious effects in this study.

According to the cognitive theory of multimedia learning, multimedia information may have deleterious effects when a single channel is overloaded. This explanation seems plausible in case of videos in this study because the visual channel is overloaded with verbal visual information received from the text and nonverbal visual information received from the videos. Another explanation that the theory provides is the ‘redundancy effect’ that might have occurred by presenting text and videos together. The reader has to process the verbal information received from the text through the eyes and from the narration in the videos through the ears along with nonverbal information received from the videos. This might have distracted the learners. On the other hand, proficiency level might have played an important role. As Chun and Plass (1997) suggest, the learner ‘may not have enough executive resources to comprehend the foreign language and all the information given’ in the annotations.

These findings suggest that we need to reconsider the effect of multimedia annotations for L2 reading comprehension. Learners perceive easy access to annotations highly useful in helping them cope with an L2 text. However, easy access may lead them to use the annotations excessively to look up even familiar information (Aust et al. 1993). Moreover, learners may select to view aids not because they are im-
important, but because they are interesting (Chun & Plass 1997). Thus, provision of additional input using a variety of presentation modes may lead to ‘redundancy’ and ‘split attention’ effects (Mayer 2001) and may thus hamper reading comprehension at this level.

Pedagogical implications

The results have implications both for teachers and material developers. Intermediate-level EFL learners seem to prefer visual information to help them understand a text. They have positive attitudes towards reading on the computer because of the capability of the computer to provide such information. However, the presentation of visual information along with additional information through different channels may not necessarily facilitate reading comprehension. Mayer (2001) provides several principles that could be used in designing multimedia environments. However, these principles are based on research conducted with native speakers of English and may not be applicable in case of L2 learners. Thus, they should be followed with caution. Moreover, while annotations may be useful in helping learners build schemata about a given topic, learners at lower proficiency levels may not have the resources to process such additional information. Thus, it is recommended that hypermedia activities be integrated into the reading curriculum and learners be trained in effective reading strategies for such an environment such as knowing when to read a definition or an explanation (Venezky 1994) or establishing the relations between graphics and text (Hedley et al. 1994; Bolter 1998).

Limitations of the study

Several limitations have been identified in this study; therefore, study findings should be taken into consideration accordingly.

First, an experimental study that better controls confounding variables should be conducted for more accurate inferences about the effect of hypermedia annotations on reading comprehension. Moreover, qualitative data such as the kind obtained from think aloud protocols would provide deeper insights into the process of utilizing annotations while reading the hypermedia text. Second, inferences in this study are made based on a reading task that required both reading for general comprehension and reading for specific information. Thus, the findings apply only to those situations where a similar task is involved. Third, attempts need to be made to ensure that all the annotations are of equal quality. In this study, annotations were prepared based on available resources. Thus, some annotations might have provided more valuable information than others. Fourth, the findings of the study cannot be generalized to other contexts and proficiency levels unless the study is replicated in the different contexts and with different proficiency levels. Finally, there may be other factors that are closely related to learners’ interaction with a hypermedia text such as proficiency level, reading goals, reading strategies, experience with computers, reader’s interest in the topic, and learning styles. These factors were not investigated in this study, and they may be closely related to annotation use and reading performance.

References


