
Exploring ESL Learners' Use of Hypermedia Reading Glosses

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ABSTRACT

This study explores the types of annotations intermediate and advanced ESL learners preferred to use while they were engaged in reading a hypermedia text. The study also investigated learners' attitudes towards reading in a hypermedia environment. The participants were 84 ESL adult learners enrolled at the Center for English as a Second Language at the University of Arizona. Data were collected through a tracking tool, a reading comprehension test, a questionnaire, and interviews. Quantitative data indicated that the intermediate ESL learners accessed annotations more frequently than those in the advanced group. However, they did not differ in the amount of time they spent on annotations. On the other hand, the advanced learners performed better on the reading comprehension test. Both groups of learners preferred word definitions to pronunciations of words and graphics in order to get information about the text at the word level. However, they preferred videos and graphics to get extra information about the topic. Analysis of the qualitative data revealed that hypermedia reading had a positive impact on the participants' attitudes towards reading on the computer. The participants indicated that the hypermedia environment made reading more enjoyable and comprehensible.

KEYWORDS

Hypermedia, L2 Reading, Annotation Use, Proficiency Level

INTRODUCTION

New digital technologies such as hypermedia, hypertext, or multimedia have great potential for teaching and learning because of the innovative ways they present information and the control and freedom they give learners over their learning (Means, Blando, Olson, Morocco, Remz, & Zorfass., 1993; Heller, 1990; Marsh & Kumar, 1992; Roblyer, Edwards, & Havriluk, 1997; Popkewitz & Shutkin, 1995). Hypermedia combines hypertext and multimedia within one system (Jonassen, 1996). In other words, hypermedia environments such as those found on the web or in electronic books utilize text, sound, graphics, video, and animation in the same document and present information in a nonlinear fashion through nodes and links. Thus, hypermedia is a type of multimedia distinguished by the richness and depth of information it provides through links and multiple presentation modes (Preece, 1993).



Although hypermedia provides “flexible information environments” (Goldman, 1996), reading hypermedia documents poses certain challenges for readers. Successful reading comprehension in a hypermedia environment goes beyond effective uses of top-down and bottom-up processes; it requires additional reading skills to cope with the demands of the new environment. For instance, readers need to be able to interpret visual images, video, film, charts, and tables (Lemke, 1998), navigate through complex and continually changing systems of information, (Leu, 1999), make decisions concerning when to read a definition or an explanation (Venezky, 1994), distinguish relevant and reliable information and make connections between discrete bodies of information and their relative importance (Synder, 1998; Landow, 1992), and monitor their reading in order not to become distracted from their reading purpose.

Hypermedia texts are mostly organized in a nonlinear manner because information is provided through nodes or links which may take readers to different types of glosses or annotations to help them understand the text better. Hypermedia glosses may be presented before or during reading; they may function to highlight or clarify important points or simply to provide lexical or syntactic information; their focus may be textual or extratextual; they may be provided within the body of text or outside the text; they may come in the form of text, images, sound recordings, or videos (Roby, 1999). Glossing is particularly useful in second language reading (L2 reading); words or phrases that are judged to be outside learners' current competence may be explained through glosses or annotations (Widdowson, 1984).¹ Thus, a given text may be made comprehensible for L2 readers without reducing its authenticity.

REVIEW OF RELATED LITERATURE

Few research studies have investigated ESL learners' use of computerized reading glosses. For instance, questions such as “Do ESL learners find computerized glosses useful for reading comprehension?” or “What types of glosses do they prefer and find useful?” remain largely unanswered. One tool that goes a long way to facilitate research is the use of a tracking tool which allows researchers to follow what learners actually do when they are engaged in a particular hypermedia learning task. Tracking learners' interaction with the text may help researchers trace and explore learners' reading strategies (Blake, 1992) and provide valid means for process-oriented research (Hulstijn, 1993). Thus, such technology may provide insights into both the product and the process of learning (Collentine, 2000).

Aust, Kelley, and Roby (1993) investigate fifth-semester Spanish learners' preferences regarding computerized and conventional dictionaries, which were referred to as hyper-references and paper references, respectively. The researchers found that participants who had access to bilingual hyperreferences made more consultations than those who had access to monolingual hyperreferences, bilingual paper references, or monolingual paper references. Monolingual hyperreferences were also used more frequently than the bilingual and mono-



lingual paper references. However, whether references were bilingual or monolingual did not make a difference when they had access to conventional references. Thus, the study suggests that learners prefer computerized bilingual dictionaries for second language reading. However, no differences among the groups were found with respect to reading comprehension.

Roby (1999) reports on an experimental study which investigated Spanish learners' use of paper and computer dictionary and glosses. While the dictionaries provided lexical information, the glosses contained "the meaning of an item in context." Roby found that learners who had access to computer dictionaries looked up substantially more words than those who had access to paper dictionaries. Moreover, the participants in the dictionary + gloss condition read the text in less time than those in the dictionary-alone condition. This study did not find any differences among the groups on reading comprehension. Unfortunately, insufficient numbers of such studies do not allow us to make any generalizations about L2 learners' use of computerized glosses and their attitudes about computerized reading.

Lomicka (1998) describes a pilot study which investigated the use of various types of glosses (i.e., images, references, questions, pronunciation, and translations in English) by 12 intermediate-level French learners. The tracker data revealed that the participants preferred definitional glosses to other types of glosses. Despite the small sample size and lack of statistical evidence, this study is useful because of its attempt to explore learners' preferences for different types of glosses.

The computerized glosses investigated by Davis and Lyman-Hager (1997) were English definitions, French definitions, grammar explanations, pronunciation, cultural background, and pictures. Forty-two randomly selected intermediate-level French students were given a literary text to read and then a multiple-choice test and a recall protocol in English. The tracking tool revealed that 85% of the information accessed was English definitions of words. Results showed a negative relationship between grade level and frequency of access to glosses. Thus, the frequency of access to the glosses decreased as the grade level increased. On the other hand, the exit interviews indicated that a majority of the participants found computerized glosses "helpful," "time-saving," "easy," and "enjoyable."

Knight (1994) investigated the relationship between verbal ability, lookup behavior, and reading comprehension (measured through recall protocols). One hundred and twelve intermediate-level Spanish students were randomly assigned to dictionary-access and no-dictionary-access conditions. The analyses of the tracker data revealed that students in the low verbal ability group who had access to a dictionary scored significantly higher than those who did not. However, access to a dictionary did not have an effect on the reading comprehension of high verbal ability learners. Thus, there was a substantial relationship between reading comprehension and word lookup for the low ability group, whereas the relationship was negligible for the high ability group. Moreover, Knight



found that the dictionary group spent more time on task in both low and high ability groups. However, only in the low ability group did increase in reading time lead to better comprehension.

Finally, the Chun & Plass (1996) study is also worth noting because of its investigation of the effectiveness of different media types and their combinations. Although the study focuses on vocabulary learning, its findings have important implications for the use of multimedia annotations in L2 learning. The researchers conducted three successive experiments with the same procedures but different vocabulary tests. The second experiment is reported here due to its large sample size. One hundred and three second-year German students were given a reading text that was annotated using text (i.e., definitions in German), pictures, and video. Some words were annotated using only text; others had a combination of text and pictures or text and video annotations. Participants were given a 36-item vocabulary test after reading. They were also asked to report the type of annotation they remembered first when they read the word on the test and to indicate the type of information used to recall the word. The mean scores for correct answers with respect to annotation type revealed significant differences between scores for words annotated with text + pictures and those annotated with text only. The words with only text annotations had the lowest retention rate, whereas words with text + pictures annotations had the highest retention rate. Moreover, participants stated that they used cues from pictures more than cues from text and video to recall the words; the video was hardly reported as the retrieval cue. The authors suggested that a combination of verbal and visual information leads to better learning. The findings also indicate that not all combinations of media are as effective and that motion in video may detract attention from meaning.

The studies reviewed above revealed some important findings regarding the effectiveness and usefulness of computerized glosses for ESL reading. Both Roby (1999) and Aust, et al. (1993) showed that easy access to glosses increases the frequency of consultation and reduces study time, yet they did not find any effects of these glosses on reading comprehension. On the other hand, Knight (1994) and Davis and Lyman-Hager (1992) uncovered the effects of two other variables that may be interacting with the effects of glosses: verbal ability and proficiency. These studies suggest that computerized glosses may be more beneficial for low verbal ability and low proficiency learners. Lomicka (1998) and Davis and Lyman-Hager (1997) found that learners prefer definitional glosses over other kinds of annotations for reading comprehension. Finally, Chun and Plass' study was distinguished from the other studies with its focus on media types; they found that a combination of text and pictures was more effective for vocabulary learning than text alone or text with video.

The purpose of the study presented here is to systematically explore intermediate and advanced ESL learners' interaction with a hypermedia text. The study investigates the following two questions: (a) What types of annotations do learners prefer to use when they are engaged in reading a hypermedia document?



and (b) Are there any differences between intermediate and advanced learners with regard to their use of hypermedia annotations?

METHODOLOGY

Participants

Eighty-four participants learning English for academic purposes at the University of Arizona took part in this study. They came from a variety of language and cultural backgrounds: Arabic (29), Spanish (16), Japanese (13), Korean (10), Chinese (5), Indonesian (2), Portuguese (2), Thai (2), Bulgarian (1), Turkish (1), German (1), Pular (1), and Vietnamese (1). The average age of the participants was 24.06 years, ranging from 17-40 years of age. Students were placed at proficiency levels based on their performance on the Listening and Structure sections of a standardized placement test: *A Comprehensive English Language Test for Learners of English*. There were 34 intermediate- and 50 advanced-level learners.

Materials

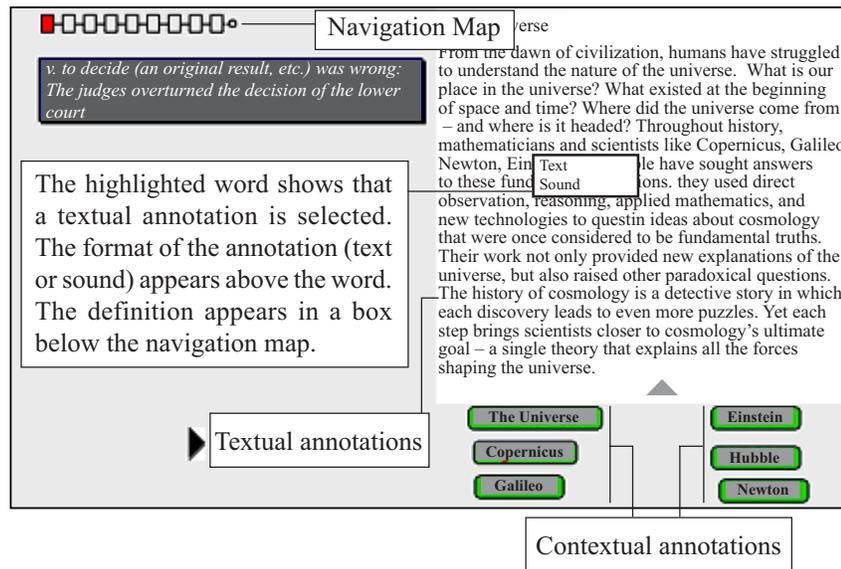
An electronic reading text entitled “Stephen Hawking’s Universe” was adapted from the Public Broadcasting Service web site (www.pbs.org/wnet/hawking/html/home.html). In order to aid reading comprehension, the text was annotated using multiple forms of digital media created by using *Macromedia Director*, version 7.1.2. Based on the interactive theory of reading (Rumelhart 1977; Kintsch & Van Dijk, 1978; Bernhardt, 1991), the annotations were aimed at facilitating both top-down and bottom-up processes. Thus, they were categorized as (a) *textual annotations*—those providing information about the text such as definition of a word and its pronunciation, or (b) *contextual annotations*—those providing background information about the topic.

Textual annotations were provided within the body of text, whereas contextual annotations were provided outside the text. When participants clicked on a highlighted word, phrase, or a background information button, they could see in what form or forms of media the information was available (i.e., text, graphics, sound, or video). They were then able to choose and view as many annotations as were provided in the hyperactive link (see Figure 1).

Textual annotations involved three types of media: text, sound, and graphics. *Text* provided the definition of a word or phrase and its grammatical form—noun, adjective, verb, and so forth. *Sound* annotations provided the pronunciation of a word or phrase via audio recordings. *Graphics* annotations provided photos or drawings to illustrate the word, notion, or idea. Contextual annotations were of four types: text, sound, graphics, and movie. *Text* provided extra information on the topic in textual format. *Sound* involved audio recordings related to the topic. *Graphics* involved pictures or drawings related to the topic. Finally, *movie* involved digital videos about the topic.



Figure 1
Sample Hyperactive Reading Passage



In summary, the annotations are categorized as follows:

1. textual text annotations: dictionary definitions of words,
2. textual audio annotations: pronunciations of words,
3. textual graphics annotations: pictures or drawings describing the meanings of words,
4. contextual text annotations: extra information about the topic in the form of text,
5. contextual audio annotations: sound recordings providing extra information about the topic,
6. contextual graphics annotations: pictures, drawings, or photos providing extra information about the topic, and
7. contextual video annotations: digitized movies providing extra information about the topic.

The software tracked every interaction of the readers with the text, including which annotations readers had chosen to view, how much time (in seconds) they spent on a particular annotation, and the order in which they selected the annotations. This information was saved in a log file for each reader.

Once the participants finished reading the text, they were given a 14-item reading comprehension test on the computer. This test consisted of short-answer, multiple-choice, and open-ended questions. Participants did not have access to the reading text during the test, but they were allowed to take notes while reading the text and use their notes during the test. Upon quitting the test, each participants' responses to the questions were also saved in a log file.



Procedures

The participants took part in the study during their regular class periods. They were told that this study was aimed at exploring their reading strategies in a computer environment. It was also emphasized that participation in the study was voluntary and that it would not affect their performance in the class.

The data collection consisted of two major phases. The first phase lasted two class periods. During this part of the study, participants were given a demonstration on how the software worked. Then, they were asked to read the text for its content and use the annotations to help them understand the text better. They were told that they would be given a comprehension test when they finished reading, that they would not have access to the text during the test, and that they should take notes on the paper provided. Although the comprehension test did not include any information from the annotations, this was not indicated to the participants so that they would not opt to read the text only instead of using the annotations. When they quit the software, two log files were saved on the hard disk: one for the participants' interaction with the text and the other for their answers to the comprehension test questions. Finally, some of the participants filled out a background questionnaire the same day, while others did so the next day. The background questionnaire involved questions regarding the demographic information about the participants as well as their perceptions about the usefulness of annotations.

The second phase of the study involved interviews with 20 volunteering participants within three days after they took part in the study. The goal of the interviews was to obtain in-depth data about the participants' attitudes about reading a text in a hypermedia environment and the usefulness of the annotations.

Data Analysis and Results

Before discussing the results of the analyses, a brief discussion about the difficulty of the text is in order. The data regarding the difficulty of the text were obtained from the questionnaire the participants completed after they participated in the study. The participants were asked to rate Vocabulary, Grammar, and Content from 1 to 5, 1 being very easy and 5 being very difficult.

Independent-samples chi-square tests were conducted in order to ascertain whether the differences between the two groups were statistically significant. Results indicated that the groups were statistically different in their ratings of Vocabulary ($\chi^2 = 9.97, p = .006$) and Grammar ($\chi^2 = 8.25, p = .01$), but not Content ($\chi^2 = 4.16, p = .12$). In other words, the intermediate group considered Vocabulary and Grammar significantly more difficult than the advanced group. However, the difficulty level of Content was similar for both groups.

Since the difficulty level of certain aspects of the text was different for the groups, it was hypothesized that the two groups would interact with the text differently. In other words, they would differ in their use of the annotations



incorporated into the text. The frequency with which the annotations were accessed, the amount of time spent on annotations, as well as the total amount of time spent reading the text were variables investigated with regard to participants' interaction with the text.

Frequency of Access to Hypermedia Annotations

The number of clicks made by the participants to view the annotations determined the frequency of access to annotations. Participants could click on a given annotation as many times as they wished. Whether there were any differences in each group with regard to access to each type of annotation and whether the two groups differed in their access to annotations were analyzed by a two-way mixed-design ANOVA with one grouping variable (proficiency level) and one within-subjects variable (annotation type). Hence, language proficiency was the independent variable with two levels (intermediate and advanced), whereas the annotation type was the dependent variable with seven levels measured on an interval/ratio scale.

Tables 1 and 2 show the means and the standard deviations for the frequency of access to textual and contextual annotations. Note that the means indicate the ratio of the total number of times the participants accessed a given annotation to the total number of times that annotation occurred in the software.

Table 1
Means and Standard Deviations for Frequency of Access to Textual Annotations

Proficiency level	Text		Audio		Graphics	
	M	SD	M	SD	M	SD
Intermediate (n = 34)	0.49	0.30	0.38	0.36	0.37	0.40
Advanced (n = 50)	0.43	0.30	0.21	0.26	0.19	0.23

As Table 1 indicates, the intermediate group accessed the textual annotations more frequently than the advanced group. Both groups accessed word definitions the most and graphics the least.

Table 2 shows that the intermediate group accessed all of the contextual annotations more frequently than the advanced group. The highest mean for both groups was access to the video annotations. The second most accessed annotation type was text for both groups, while sound recordings were accessed the least.



Table 2
Means and Standard Deviations for Frequency of Access to Contextual Annotations

Proficiency level	Text		Audio		Graphics		Video	
	M	SD	M	SD	M	SD	M	SD
Intermediate (n = 34)	1.21	0.79	1.04	0.75	1.17	0.77	1.97	1.48
Advanced (n = 50)	1.16	1.08	0.63	0.56	0.75	0.58	1.24	0.98

The intermediate group had a higher mean for all types of annotations. They used all types of annotations consistently more than the advanced group. On the other hand, the groups showed similarity in terms of the types of annotations they preferred. Both groups accessed the textual graphics and the textual audio annotations the least, whereas the contextual text and the contextual video annotations were accessed the most.

Prior to performing repeated-measures analyses of variance tests, the sample data were checked for the assumptions of ANOVA. Descriptive statistics indicated that several variables were not normally distributed. Therefore a square-root transformation was conducted to reduce heterogeneity of variance between the groups. Moreover, the sphericity assumption, which requires identical population variances and covariances 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. Thus, the decision about whether an F-test was significant was made based on the Geisser-Greenhouse epsilon.

In order to examine the group means regarding annotation use, a 2 x 7 repeated-measures ANOVA was conducted. Table 3 shows the results of the ANOVA test.

As Table 3 indicates, there was not a significant interaction effect for Proficiency Level x Annotation Type, $F(6, 492) = 1.79, p = .09$. The main effect for Proficiency Level was significant $F(1, 82) = 6.94, p = .0001$. The main effect for Annotation Type was also significant, $F(6, 492) = 63.83, p = .001$.

The nonsignificant interaction effect indicates that access to different types of annotations does not depend on the proficiency level. The main effect for Proficiency Level suggests that overall the intermediate group accessed the annotations significantly more frequently than the advanced group. The main effect for Annotation Type suggests that the two groups as a whole accessed some annotations significantly more frequently. Figure 2 shows the main effect for Annotation Type.

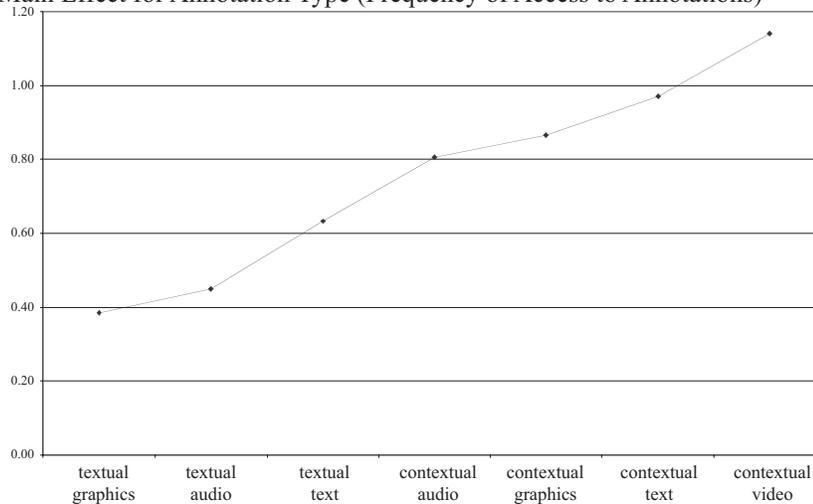


Table 3
ANOVA Summary Table for the Frequencies of Access to Annotations

Source	df	SS	MS	F
Between subjects	83			
Proficiency level	1	4.17	4.17	6.94*
Error	82	49.18	0.60	
Within subjects	504			
Annotation type	6	36.67	6.11	63.83**
Annotation x proficiency	6	1.03	0.17	1.79
Error (within)	492	47.11	0.10	
Total	587			

* $p < .01$, ** $p < .001$

Figure 2
Main Effect for Annotation Type (Frequency of Access to Annotations)



The main effect for annotation type was further analyzed using post hoc comparisons in order to uncover which types of annotations were accessed significantly more frequently. Post hoc comparisons were computed using the Bonferroni procedure to adjust the criterion alpha level ($.05/12 = .004$) so that the inflation of the Type I error rate would be prevented. Hence, 12 contrasts were conducted comparing textual annotations among themselves, contextual annotations among themselves, and textual and contextual annotations with each other.

Post hoc comparisons indicated that all the contextual annotations were accessed significantly more than the textual annotations. Moreover, the comparisons among the textual annotations revealed that the textual text annotations



(word definitions) were utilized significantly more than textual audio annotations (pronunciation), and textual graphics annotations. As for the contextual annotations, the video annotations were accessed significantly more than all the other types of contextual annotations. The comparison between audio and text was also significant; text was accessed more frequently than audio. No other comparisons were significant.

In summary, contextual annotations were accessed significantly more frequently than the textual annotations. Among the textual annotations definitions of words were accessed the most, and among the contextual annotations video and text annotations were accessed the most.

The Amount of Time Spent on Annotations

The determination of the amount of time participants spent on hypermedia annotations was based on the amount of time they viewed the annotations. Since the annotations appeared only while the mouse button was down, the amount of time the participants kept their hands on the mouse was considered to be the time they viewed a given annotation. Annotations viewed for less than one second were not tabulated.

Tables 4 and 5 provide the means and the standard deviations for the amount of time (in seconds) spent on annotations. Note that the time indicated in the tables is the ratio of the total amount of time the participants spent on a given annotation to the total amount of time devoted for that annotation type in the software.

Table 4
Means and Standard Deviations for the Amount of Time Spent on Textual Annotations

Proficiency level	Text		Audio		Graphics	
	M	SD	M	SD	M	SD
Intermediate (n = 34)	0.51	0.36	0.25	0.23	0.15	0.19
Advanced (n = 50)	0.45	0.35	0.18	0.25	0.12	0.20

There were slight differences between the groups with respect to the amount of time they spent on the textual annotations. The intermediate group spent slightly more time on the textual annotations than the advanced group. Both groups spent the most time on word definitions and the least time on graphics.

The intermediate group spent more time on the contextual annotations except for contextual text annotations. The annotations that were most utilized also differed between the groups. The intermediate group spent the most time on graphics, but they spent the least time on text. On the other hand, the advanced



group spent the most time on videos and the least time on sound recordings.

Descriptive statistics indicated that several variables were not normally distributed. Therefore a square-root transformation was conducted to reduce heterogeneity of variance. Mauchly's sphericity test was utilized in cases where the sphericity assumption was violated.

Table 5
Means and Standard Deviations for the Amount of Time Spent on Contextual Annotations

Proficiency level	Text		Audio		Graphics		Video	
	M	SD	M	SD	M	SD	M	SD
Intermediate (n = 34)	0.33	0.38	0.41	0.39	0.70	0.47	0.53	0.38
Advanced (n = 50)	0.37	0.42	0.33	0.45	0.48	0.42	0.52	0.42

A 2 x 7 repeated measures ANOVA was conducted to test whether the mean differences between the two groups as well as the differences within each group with respect to the amount of time spent on each type of annotation were different (see Table 6).

Table 6
ANOVA Summary Table for the Amount of Time Spent on Annotations

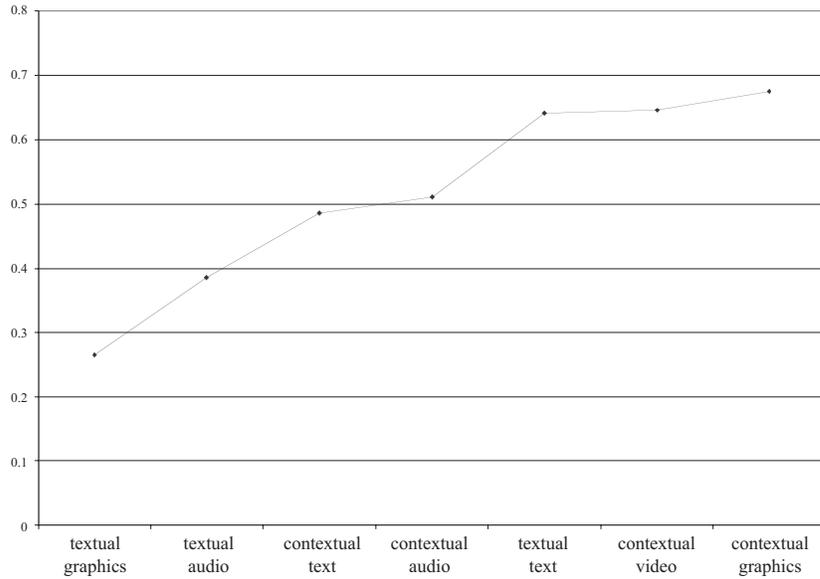
Source	df	SS	MS	F
Between subjects	83			
Proficiency level	1	0.63	0.63	2.43
Error	82	21.20	0.26	
Within subjects	504			
Annotation type	6	11.45	1.91	26.44*
Annotation x proficiency	6	0.38	0.06	0.89
Error (within)	492	35.50	0.07	
Total	587			

* $p < .001$

The ANOVA results revealed a nonsignificant interaction effect for Proficiency Level x Annotation Type, $F(6, 492) = 0.89, p = .51$. The main effect for Proficiency Level was not significant either, $F(1, 82) = 2.43, p = .12$. The main effect for Annotation Type was significant, $F(6, 492) = 26.44, p < .001$. These results suggest that the amount of time the participants spent on annotations did not depend on their proficiency level. The groups did not differ significantly from each other in the overall amount of time they spent on annotations either. However, the groups as a whole utilized certain annotations significantly more than others. Figure 3 shows the main effect for Annotation Type.



Figure 3
Main Effect for Annotation Type (Amount of Time Spent on Annotations)



Post hoc comparisons with a Bonferroni correction ($0.05/12 = .004$) were conducted in order to follow up the main effect for annotation type. Contrasts were made among the textual annotations, contextual annotations, and textual versus contextual annotations. The results indicated that the textual text annotations were utilized significantly more than the contextual text annotations. Moreover, significantly more time was spent on the contextual audio annotations than the textual audio annotations. The contextual graphics annotations were also utilized more than the textual graphics annotations. Comparisons among the contextual annotations revealed that significantly more time was spent on graphics annotations than text and audio annotations. The comparison of video annotations with audio and text was also significant, more time being spent on videos. No other comparisons were significant. Among the textual annotations, significantly more time was spent on word definitions than pronunciation and graphics. The comparison between pronunciation and graphics was not significant. In summary, the participants utilized word definitions to decode the text, whereas graphics and videos were utilized to get extra information about the topic.

Total Time Spent on Reading the Text

Whether the groups differed in the total amount of time they spent on reading or studying the text was investigated through an independent samples *t* test. The results of the descriptive statistics indicated that the intermediate group spent



more time on reading the text ($M = 44.47$ minutes, $SD = 13.62$) than the advanced group ($M = 36.67$ minutes, $SD = 11.90$). The distribution for both groups was normal (skewness = 0.19, kurtosis = -0.45; $W = 0.97$, $p = .53$ for the intermediate group; skewness = -0.17, kurtosis = -0.27; $W = 0.99$, $p = .8$ for the advanced group). The test for equal variances revealed that the variances were homogenous.

The results of the independent samples t test indicated that the difference in the total amount of time spent in reading the text between the two groups was significant ($t(82) = 2.78$, $p = .007$). Thus, the intermediate group spent significantly more time on reading or studying the text than the advanced group.

Performance on the Reading Comprehension Test

The performance of the groups on the reading comprehension test was compared through an independent samples t test. Results of the descriptive statistics showed that the mean score for the intermediate group was lower ($M = 9.16$) than that of the advanced group ($M = 11.72$). The highest possible score on this test was 22. Both distributions were normally distributed, and variances between the groups were found to be homogenous (see Table 7).

Table 7
Results of the Descriptive Statistics for Reading Comprehension Scores

Proficiency level	M	SD	Min	Max	Mode	Skewness	Kurtosis
Intermediate (n = 34)	9.26	4.21	3	18	6	0.58	0.16
Advanced (n = 50)	11.72	4.55	3	22	9	0.16	-0.53

An independent samples t test indicated that the difference in the mean reading comprehension scores between the intermediate and advanced groups was significant ($t(82) = -2.5$, $p = .01$). Thus, the advanced group performed significantly better on the test than the intermediate group.

Insights from the Questionnaires and Interviews

A qualitative investigation through the questionnaire and interviews provided valuable information regarding the participants' perceptions of the usefulness of annotations and their experience of reading in a hypermedia environment.

All the participants who were interviewed indicated that they enjoyed reading on the computer; it was different from the readings they did in class. They defined reading on the computer as "more interesting," "easier," and "comprehensible." Participant 1 defined his experience as follows:

You read, you see, and you hear at the same time. You can easily see the definitions of words and don't lose time on that, and you continue to



read. You decide your reading speed. You feel shy about asking questions in the class, but you don't feel shy with the computer. You control your reading.

Participant 2 also provided a similar response:

Most of the times when I'm reading something that my teachers gave me for homework and to answer questions, I have to read and read and read again, maybe three times because ... to answer the questions. Sometimes the questions are very specific. For that kind of reading, I have to read again. And, also, I have to look for the words I don't understand in the dictionary in order to understand the meanings. In the program you gave us, I am sure that I understood very well everything. If I didn't understand the topic or the issue, the program gave me a little bit more information about it, talking to me or showing me movies all that kind of things ... and also the meanings of words that I don't know.

Thus, the emphasis in these comments was on the usefulness of multiple forms of media to present information as well as the interaction between the participants and the text. Reading on the computer was more interactive. Participants were able to choose annotations based on their needs or interest. Hence, they had control over their reading.

Participants were asked to rate the usefulness of each type of annotation. Tables 8 and 9 indicate the results of their rating.

Table 8
Usefulness of Annotations Rated by the Intermediate Group

		Not at all useful (1)	Slightly useful (2)	Useful (3)	Very useful (4)	Essential (5)
Annotations that provided information about words	Text (definition)	0	6	45	29	19
	Audio (pronunciation)	3	17	43	27	10
Annotations that provided extra information about the topic	Text	3	16	19	39	23
	Audio	6	16	19	35	23
	Graphics	3	13	17	40	27
	Video	3	10	10	34	41

The majority of the intermediate group rated definitions and pronunciations of words "useful." This group also rated all types of contextual annotations either "very useful" or "essential." Thus, the ratings suggest that the intermediate learners perceived the annotations to be useful for text comprehension.

The advanced group rated word definitions either "very useful" or "essential." The usefulness of pronunciations of words did not get a high rating from this group. As for the contextual annotations, the majority of the advanced learners rated text, graphics and video either "very useful" or "essential." However, there does not seem to be an agreement on the usefulness of audio.



Table 9
Usefulness of Annotations Rated by the Advanced Group

		Not at all useful (1)	Slightly useful (2)	Useful (3)	Very useful (4)	Essential (5)
Annotations that provided information about words	Text (definition)	0	6	23	35	35
	Audio (pronunciation)	11	17	28	28	13
Annotations that provided extra information about the topic	Text	2	6	26	30	36
	Audio	4	31	29	27	9
	Graphics	9	6	21	40	23
	Video	7	4	22	33	35

The participants who were interviewed found the annotations useful in different ways. Participant 2 stated: "I think all of them are very useful. You can understand perfectly the meaning. I cannot say that only one of the things is going to help me a lot."

Participants referred to the textual annotations as "the dictionary," including the definitions of words, the pronunciations of words, and the visual aids explaining the meanings of words. Participant 3 indicated: "The dictionary helped very much what I am reading." For Participant 1, textual annotations increased the efficiency of reading: "It saves time, and you can go back to reading without getting bored and forgetting what you read. It increases the speed of reading."

For all of the participants, definitions of words were "necessary" or "essential." Some considered pronunciation not very important to understanding the text, but, for some, it was still useful because, as stated by Participant 4, "Pronunciation is one of the most difficult things in English. Any opportunity to improve pronunciation is very important."

Some participants indicated that they used almost every textual annotation although they do not tend to use a dictionary much when they are reading from paper. This provides evidence that if the annotations are easily accessible, they may be used excessively. As emphasized by Participant 4: "I wish you had put an explanation on every word."

While there was consensus on the importance of textual annotations, there were mixed responses about the usefulness of the contextual annotations. Some considered videos unessential to understanding the text and even distracting as indicated by Participant 5: "It is useful, but less than pictures because with the movie you have to pay attention. The picture gives you an idea, but the movie, you're seeing and you're thinking. Maybe it's boring. After that you return to the text, maybe you're confused or something like that." On the other hand, some participants did not consider the video annotations distracting because they were "focused."

For those who already had some background information about the topic, contextual annotations were useful. Participant 6 indicated: "Multimedia, sound, and the movie keep you interested." These participants chose the contextual annotations based on their "interest" or "curiosity," as indicated by Participant 7: "I wanted to improve my knowledge, of course there was curiosity... What



am I going to see about the space? What does a black hole look like? What does Stephen Hawking look like? How does he sound? These were all interesting.” Participant 7 also emphasized: “I’m not sure which one is more useful, they increase our curiosity more. Seeing is believing.” On the other hand, those who did not have prior knowledge about the topic viewed the annotations to understand a concept better, not because of interest. Participant 8 stated: “I think when you see the movie and when you see the information, you have more chance to understand.”

Some emphasized that they used videos and graphics because they were visual learners. This was the case for Participant 2: “I think it is a waste of time for me to have to look for words and then to have to understand the meaning. It is better to me to show the idea like a movie ... you get the idea better. I think it is more fast to understand.”

Some did not view any of the contextual annotations because they thought they were in a testing environment and there was not enough time to see the contextual annotations. Participant 10 indicated: “If I use movies, I can’t answer the questions.” Similarly, Participant 11 said: “At the time, I just think this is a test. I need reading very fast and answer the questions.” Participant 12 also thought there was not enough time to view the contextual annotations: “If there was longer time, I would see everything.”

Finally, for some participants contextual annotations offered too much information, and they thought it was not necessary to use the contextual annotations to understand the text. For instance, Participant 7 viewed most of the contextual annotations, but he also stated: “My new understanding of the universe is from the reading, not from the movies or picture.”

Summary

The text used in this study was more difficult for the intermediate group. Therefore, their interaction with the text and their reading performance were different from those of the advanced group. The intermediate group accessed all types of annotations more frequently than the advanced group. However, they did not necessarily spend more time on them. As a matter of fact, the amount of time spent on the annotations was not different between the two groups. The groups as a whole accessed the topic-level annotations more frequently than the annotations providing word-level information. Text and video were the most frequently accessed annotations in order to get extra information about the topic, whereas definitions of words were accessed the most in order to get word-level information. However, there does not seem to be a close relationship between the frequency of access to annotations and the amount of time spent on annotations. Participants spent the most time on visual aids (graphics and videos) in order to get extra information about the topic, whereas word definitions were, again, mostly utilized word-level annotations. Interviews revealed that most of the participants considered graphics and video annotations interesting and mo-



tivating. Moreover, they agreed that word definitions were very useful in helping them understand the text.

The participants did not agree on the usefulness of contextual annotations in aiding reading comprehension, but they did agree that word definitions were essential. Interviews indicated that the participants with prior knowledge utilized contextual annotations differently from those without prior knowledge. For those with prior knowledge, extra information about the topic was utilized because of "curiosity" or "interest," while those without prior knowledge utilized them to understand the concepts better.

The amount of time it took the intermediate group to read the text was much longer than the advanced group. However, the advanced group performed better on the reading comprehension test. Thus, despite the efforts of the intermediate group to understand the text by utilizing more annotations and spending more time on studying or reading the text, they still were not able to reach the level of performance displayed by the advanced group.

DISCUSSION

This study provided evidence for the positive impact of hypermedia on the learners' perceptions of their reading experience. The provision of authentic input and interaction between the reader and the text were found to be important features of hypermedia, leading to positive attitudes. The authentic input aroused the readers' interest because the linguistic input was contextualized and, therefore, easier to understand. As indicated by one of the participants, they were able to fulfill their curiosity about "what Stephen Hawking looked like and how he sounded."

Interviews revealed that the participants enjoyed interacting with the text at their own pace and selecting information based on their own needs and interests. The individualized reading gave them control over the reading process. Hence, the interactivity between the reader and the text motivated the participants in the reading process.

Significant differences were found between intermediate and advanced learners with regard to their use of hypermedia annotations. The intermediate learners consistently accessed both textual and contextual annotations more frequently than the advanced learners. This result suggests that they were trying to compensate for their lower level of language proficiency by utilizing annotations both at the word level and topic level. Moreover, advanced learners accessed annotations less frequently than the intermediate learners, confirming Knight's (1994) finding that lookup frequency decreases as proficiency level increases. Higher proficiency learners seem to spend more time reading the text itself than using annotations or glosses.

An interesting finding was that the intermediate learners did not spend more time on the annotations than the advanced learners, even though they accessed them more frequently. Thus, the intermediate learners did not utilize the annotations as much as they would be expected to, based on the frequency with



which they accessed the annotations. For instance, they might have accessed video information, but they probably did not watch the videos to the end; or they started reading extra information about the topic, but they did not finish reading all the information. This pattern of use suggests that the intermediate group might have had difficulty in comprehending the annotations because of their lower level of proficiency.

Finally, an examination of the specific types of annotations used by the learners revealed that both intermediate and advanced learners preferred word definitions in order to decode the text. They preferred visual information (i.e., graphics and videos) to get schematic information about the topic. The usefulness of these annotations was rated highly by the participants.

Pedagogical Implications

Interactivity, authenticity, and multimodal learning are important characteristics of a hypermedia environment for L2 reading. Interaction between readers and text provides individualized learning (Soo, 1999) and promotes learner autonomy (Healey, 1999). Learners get a chance to read at their own pace, select information based on their interests and needs, and take responsibility for their learning. As one of the participants put it, students may not be able to ask questions in a classroom environment because they feel shy or they cannot keep up with the pace of the class. These problems disappear in a hypermedia environment. Learners take control over their reading and make decisions about the amount of time they spend on reading, the pace of their reading, and the path they choose to construct a meaning. Moreover, students get actively involved in the reading process. They take the initiative to select the relevant information in the process of meaning construction. Hence, reading becomes a more personal and meaningful process for learners because they create their own meaning based on the way they interact with the text.

Provision of authentic input poses less challenge for L2 readers in a hypermedia environment because they are not only presented with authentic language but also with the means to deal with it. Annotations were considered to be highly useful for reading comprehension in this study. Easy access to annotations through multiple forms of media makes the reading of authentic texts more manageable and motivating for L2 readers. The participants of this study complained to their teachers why they could not read “like this all the time.”

Limitations of the Study

This study has several limitations, which may caution us about the results obtained. First, the target population was ESL students learning English for academic purposes. The sample consisted of intermediate and advanced level ESL learners who were enrolled at a specific US university in a given semester to learn English for academic purposes. Unless the study is replicated in other learning contexts with different samples, the findings cannot be generalized to



the general target population. Second, the reading comprehension test used in this study caused several problems. Some participants perceived that the whole purpose of the study was to test them on their reading ability. These participants did not utilize the annotations because they wanted to spend more time on the test. They also indicated that had there not been a test, they would have interacted with the text differently. Third, other factors might have influenced learners' interaction with a hypermedia text such as reading goals, learner styles, reading strategies, experience with computers, and reader's interest in the topic. These factors were not investigated in the study presented here, and they may be more related to performance and annotation use. Finally, the study did not investigate whether the difference on reading comprehension between the two groups was due to proficiency level, annotation use, or other factors. A more controlled study would be necessary to investigate the effectiveness of hypermedia annotations for reading comprehension.

Recommendations for Future Research

This study was exploratory in nature. Participants' interaction with text was not controlled for the sake of simulating a real-life task. However, an experimental study, which controls access to annotation types and investigates its relationship with reading comprehension may provide us with the true effect of annotations on performance. Second, in addition to experimental data, more qualitative data would also provide deeper insights into the reading process. For instance, using think-aloud protocols while learners are interacting with the text would provide information about the students' thinking processes and reading strategies in a hypermedia environment. Third, a longitudinal study in a context, where hypermedia is integrated into the curriculum and where learners are experienced users, would provide more valid findings than a study conducted at a given time with learners of varying computer experience. Finally, considering other variables such as learner styles, motivation, cultural background, gender, reading strategies, and how these variables may affect annotation use would add substantially to our understanding of the phenomenon.

NOTE

¹ The terms 'gloss' and 'annotation' are used interchangeably in this article. The term 'annotation' is exclusively used later when the current study is described. Annotations in the study include both definitions of difficult words or expressions as well as explanatory notes or comments about the content of a particular text.



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