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ABSTRACT

A study investigated the relative effectiveness of three kinds of computer-mediated support for developing reading comprehension among learners of Arabic as a Foreign Language (AFL). Subjects were 24 first-year students of AFL at the college level. The students were given computer-assisted reading instruction at four levels of treatment: control (use of text only); access to a glossary; access to conjugations of selected verbs in the text; and access to background information about the text. Treatments were combined in a Greco-Roman square research design. Post-treatment reading comprehension was measured by an immediate recall protocol. Results suggest that of the three-computer-mediated reading supports used, the glossary was the primary contributor to enhancement of comprehension. Further research is recommended to address different populations, different languages and language skill levels, text length, text type, degree of student control over computer supports, and transfer of learning. (MSE)

The Effects of Computer-Mediated Reading Supports on the Reading Comprehension and the Reading Behavior of Beginning American Readers of Arabic as a Foreign Language (AFL)

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ABSTRACT

The present study investigated a theoretical connection between computer technology and reading comprehension. Current models of reading emphasize the interactive nature of reading and constructive nature of comprehension. It is hypothesized that situating learning in technology creates favorable environments for beginning foreign language readers that permit them to explore the opportunities available for skilled readers and helps them overcome various text-based and knowledge-based comprehension problems. The findings indicate that of the three computer-mediated reading supports chosen for the study, the glossary support was the primary contributor to comprehension enhancement. Recommendations for future research are given as well as theoretical and pedagogical implications for second language instruction.

INTRODUCTION

During the past decade, great strides have been made in investigating new ways to structure the learning experiences of students. Educators have always searched for ways to provide students with the skills and motivation that allow them to learn on their own and become independent learners (Nisbett et al., 1987). Liberman and Linn (1991) argue that with the technological tools available "it is time to reconsider the process of learning and how to learn to reformulate the curriculum with the computer-based technology in mind" (p.374).

Generally speaking, situating learning in technology serves as a scaffolding in the early stages of learning (Cognition and Technology Group at Vanderbilt, 1990; Kozma, 1991) in the form of hints, suggestions, and supports. The major goal of "anchoring" or "situating" learning learning/instruction (Brown et al., 1989; Porter, 1989; Salomon et al., 1991) is to overcome the inert knowledge problem (Whitehead, 1929). This, according to The Cognition and Technology Group at Vanderbilt (1990), is achieved by "creating environments that permit sustained exploration by students and teachers and enable them to understand the kinds of problems and opportunities experts in various areas encounter and the knowledge experts use as tools" (p.3).

Research on computers and learning suggests several ways computers can be used to encourage students to be self-directed, autonomous learners (Liberman and Linn (1991). Computer-assisted instruction (CAI) can provide coaching and other forms of scaffolding as learners begin to apply new skills. The processing capabilities of the computer can help novices build and refine mental models so that they are more like experts.

The present study is an exploratory investigation into the effect of using compute-mediated reading supports on the reading comprehension and reading behavior of beginning learners of Arabic as a foreign language (AFL).

The theoretical framework advocated in this study is consonant with the current models of reading in both L1 and L2. These models emphasize the interactive nature of reading (Bernhardt, 1991; Rumelhart and Ortony, 1977) and the constructive nature of comprehension (Anderson &

Pearson, 1984; Anderson et al., 1977; Bernhardt, 1991; Bloome & Greene, 1984; Spiro, 1980, Rumelhart, 1980; among others).

Reading is a cognitive skill of great complexity. The problem solving activities associated with constructing meaning from a text require the use of cognitive resources. Processing that is not automatic engages the limited resources for processing of the working memory and may ultimately affect the overall quality of text processing and comprehension (Baddeley & Hitch, 1974; Britton, Glyn, & Smith, 1985; Perfetti, 1988, 1991).

The implications of the cognitive load for foreign and second language readers are perhaps more profound than for first language readers. American learners of AFL--like other second and foreign language learners-are constrained syntactically, lexically, phonologically, semantically, and strategically, and thus, have a tougher task at hand than their L1 counterparts. The implication is that cognitively demanding processes in reading--both identification and interpretation processes--may strain the limited resources of the reader's information processing system, specifically, the reader's working memory. Thus, it becomes imperative to explore ways to alleviate the cognitive overload and facilitate the reading task by enhancing the integration of the text-driven and knowledge-driven facets of reading.

L1 studies have already linked computer-mediated reading supports with enhanced reading comprehension of expository texts. Computer technology, moreover, provides new options for acquiring information from written texts thus prompting a richer, more overt and

more active interaction between the reader and the text (Daniel & Reinking, 1987; Duchastel, 1986).The question of whether or not this effect is present in foreign language reading has not yet been investigated. Little is known about how such supports impact on the reading capabilities of foreign language readers.

The Study

The present study investigated the effect on the reading comprehension and reading behavior of beginning readers of AFL during independent reading of relatively short expository and narrative texts.

Based on the theoretical connections between the technological attributes of the computer and informative texts, the following research questions will guide the present study:

Question I- Can the reading comprehension of beginning readers of Arabic as a foreign language (AFL) be influenced by using the computer to mediate reading aids?

Question II- Which of the reading supports appear to be most beneficial for beginning AFL readers?

Question III- What combination of reading supports, if any, seems to be more conducive to reading comprehension?

Question IV- Do beginning American readers of AFL make use of the reading supports provided via the computer, and if so, will some options be selected more often than others?

Literature Review

One of the obvious limitations of conventionally printed text is the relatively limited range of textual manipulations that can be employed to accommodate the complexity in any one text. The interactive characteristics of the computer, on the other hand, might be used to deal with a wider range of readers and tasks within a particular text (Reinking, 1987).

Textual manipulations in the form of adjunct questions, advance organizers, and glosses designed to enhance processing have proven to be inconsistent and short-lived in terms of their effect. This is due to their inability to account for the complex interaction among readers, texts, and tasks. CAI and the interactive processes it promotes, provide unique and diverse learning environments, stimulate a range of cognitive styles, and adapt to individual needs.

Providing readers with options to interact overtly with the text would "encourage more active processing of the text" (Reinking, 1987, p. 538). It is also believed that the ease with which readers of computer-mediated texts can access reading supports may affect their propensity to seek help when faced with comprehension difficulties (Reinking and Schreiner, 1985; Feldman and Fish, 1988, 1991). Complex skills as the ones involved in reading comprehension (e.g., inferencing, comprehension monitoring, etc.) are probably best learned and/or enhanced under conditions in which the reader is given the opportunity to work in an expert's environment where he/she is provided with selected options for enhancing comprehension.

In summary, computer technology permits the reader to interact with the text in the pursuit of meaning in a way not particularly possible on the printed page. In this condition readers may be required to monitor their comprehension and ponder the adequacy of their knowledge. Moreover, readers will have the chance to work in an expert's environment which enables them to experience the relevance and the importance of comprehension skills and aids.

DESIGN AND PROCEDURES

Subjects

The population from which the sample was drawn consisted of second and third quarter (Arabic 102 and 103) students at a large mid-western university. In all, 24 subjects took part in the study. The subjects were recruited from the Arabic 102 and 103 classes. Subjets were each compensated $10.00 for their particpation in the study.

Research Design

The overall design for the present study was quantitative in nature, involving the analysis of the reading performance of beginning American learners of AFL as measured via the immediate recall protocol. Both inferential and descriptive statistics were employed to investigate the individual and collective contribution of reading supports to subjects' reading comprehension. A Graeco-Latin squares-type design was chosen for the present study.

Figure 1
Graeco-Latin Square

		TEXTS			
TREATMENTS	1	2	3	4
1	A1	B3	C4	D3
2	C3	D2	B1	A2
3	B2	A3	D4	C2
4	D1	C1	A4	B4

Student A reads text 1 with treatment 1 1st,
text 4 with treatment 2 2nd,
text 2 with treatment 3 3rd, and
text 3 with treatment 4 4th.

Variables and Treatment Conditions Variables

There were four independent variables in the quantitative analysis of the effects of reading supports on the dependent measure, reading comprehension (Table 1).

Table 1
Class Level Information for the Four Independent Variables

Class	Levels	Values
TRT	4	CNTL TRT2 TRT3
TXT	4	1 2 3 4
ORDER	4	1 2 3 4
RSNUM	24	1 2 3 4 5 6 7 8 9 10 11 12 17 18 19 20 21 22 23 24 25 26 27 28

Number of observations in data set = 96

The major independent variable was treatment with four levels: (a) no access (text only), (b) access to Type I (glossary),(c) access to Types I and II (conjugations--past and present--of selected verbs in the passages), and (d) access to Types I, II, and III (background information about the text). The selection of the different manipulations or supports was based on several theoretical and empirical criteria. First, a reading support was selected if theory and research suggested that it is a contributing factor in reading comprehension. A second criterion relates to a reading support's potential for underscoring cognitive processing capability that may impact comprehension.

The dependent variable in Phase II of this study was subjects' responses on a 16-item attitudinal survey. This measure was analyzed qualitatively and was compared with subjects' performance on the reading comprehension task to check for any non-causal relationship between the two dependent measures.

Treatment Conditions

The present study was designed to permit comparisons among three varying conditions of textual manipulation mediated by a computer. In addition, a fourth condition--text only--was used as a baseline or control condition.

Materials

To enhance the generalizability of the results and to control for text type as an intervening variable, four different text were used in the experimental task. The texts were chosen on the bases of length, topic, difficulty, and level appropriateness.

Data Collection and Instrumentation

Data were collected individually. The data collection session included reading four experimental microtexts, typing four recalls for the texts. The session lasted approximately two hours per subject (average of 90 minutes).

Instrumentation

Immediate Recall Protocol: The instrument used in assessing reading comprehension was the immediate recall protocol. This measure was chosen because it is considered by many L2 reading experts as a direct reflection of what the reader has actually processed and understood about the text. A weighted propositional scoring instrument was developed for each text according to the procedure described by Johnson (1970). The four texts were first divided into pausal units or breath groups and then given values from 1 to 4 based on their semantic signficiance or their contribution to the understanding of text.

Recalls were written in English (subject's first language) to avoid the confounding effects of a second language (Lee, 1986). Bernhardt (1986) also asserts that if the target language is used: (a) those who score the recalls may become distracted by the grammatical errors and focus less on the student's actual comprehension; and (b) students will attend to grammar, vocabulary, and spelling in the target language and may not recall much information.

Apparatus

Hardware

Several Macintosh Classic and Plus microcomputers. The data collected for each subject was stored on computer diskettes and used for further analysis.

Software

The reading texts and reading supports were programmed especially for the study. The program simultaneously and unobtrusively collect and record the following data:

1. Overall experiment time for each subject;
2. Reading time for each text;
3. Recalling time for each protocol.
4. Number of selections made or reading supports consulted for each text.

Results

To assess the effect of three types of computer-mediated reading supports on the processing and reading comprehension of beginning readers of AFL, a Graeco-Latin square design was used for statistical analysis. A four-way (Treatment X Text X Order X Subject) mixed factor ANOVA was run for the dependent variable.

The statistical program subjected the data to an ANOVA procedure that tested the overall model which attempted to account for all possible sources of variability in the subjects' dependent measure.

Table 2
ANOVA to Test the Fit of the Entire Model

Dependent Variable: SCORE					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	32	31054.05573967	970.43924186	13.24	0.0001
Error	63	4619.35051033	73.32302397		
Corrected Total	95	35673.40625000			
		R-Square C.V.	Root MS	SCORE Mean	
		0.870510	21.02935	8.56288643	

ANOVA Results for Reading Comprehension

The ANOVA for the dependent variable of reading comprehension as measured by the written recall protocol scores produced a significant effect for all four variables ($F(1,3)=15.47$, $Pr>0.0001$; $F(1,3)=5.91$, $Pr>0.0013$; $F(1,3)=2.73$, $Pr>0.0511$; $F(1,23)=15.16$, $Pr>0.0001$) as indicated in the ANOVA Table 3.

Table 3
Analysis of Variance for Recall Protocol Scores

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TRT	3	3403.53752672	1134.51250891	15.47	0.0001
TXT	3	1299.53228037	433.17742679	5.91	0.0013
ORDER	3	601.00365634	200.33455211	2.73	0.0511
RSNUM	23	25573.15625000	1111.87635870	15.16	0.0001

What this means is that at least one level of the factor whose effect was measured (treatment) is different from the rest.

To answer the question of whether there is any significant differences in comprehension scores between the no access /Control condition (Level I) and the access treatment conditions (Levels II, III, and IV), the significance of all possible differences between pairs of treatment means (pairwise comparisons) was evaluated.

The Dunnett procedure, which controls the type I error for comparisons of all treatments against the control, was performed on the quantitative data from the recall protocol scores. Alpha was set at 0.05 (Confidence= 0.95). Table 4 shows the results of the Dunnett's *t* tests for the score variable.

Table 4
Dunnett's T tests for variable: SCORE

TRT Comparison	Simultaneous Lower Confidence Limit	Difference Between Means	Simultaneous Upper Confidence Limit	
TRT4 - CNTL	10.092	16.042	21.991	***
TRT2 - CNTL	7.550	13.500	19.450	***
TRT3 - CNTL	7.384	13.333	19.283	***

Alpha= 0.05 Confidence= 0.95 df= 63 MSE= 73.32302
Critical Value of Dunnett's T= 2.407
Minimum Significant Difference= 5.9498
Comparisons significant at the 0.05 level are indicated by '***'

Examination of table 4 points to strong main effects for the treatment independent variable. Subjects who had the

reading support available for inspection during independent reading scored higher on the recall measure than when not. This consistent pattern of the higher recall scores being achieved by the availability of computer-mediated reading supports conditions is demonstrated by the mean scores of the three treatment conditions Table 5).

Table 5
Simple Statistics for the Mean Scores of the Three Treatment Conditions

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
SCORE I	24	30.0000	19.4221	720.0	0	62.0000
SCORE II	24	43.5000	21.4679	1044.0	8.0000	76.0000
SCORE III	24	43.3333	17.0591	1040.0	19.0000	72.0000
SCORE IV	24	46.0417	16.0393	1105.0	20.0000	74.0000

A review of the means for the different conditions (control vs. treatments II, III, and IV) (Table 5) reveals that all comparisons were significant at the 0.05 level. The largest difference (μ= 16.042) was between the Control and Treatment IV means, the second largest (μ=13.500) was between the Control and Treatment II, and the least difference (μ=13.333) was between the Control condition and Treatment III. In all three pairwise comparisons, the critical value of Dunnett's T was 2.407, and the minimum significant differences was 5.9498. This finding indicates that comprehension is enhanced when readers have access to three types of reading supports mediated by the computer and that reading supports are a significant contributing factor in the students' recall protocol scores.

To investigate the individual and collective contribution of the reading supports, Tukey's

Studentized Range (HSD) Test for the score variable was performed. In all, 12 pairwise comparisons were performed, including three pairwise comparisons with the Control. The Alpha for the 12 pairwise comparisons was set at p> 0.05 (confidence= 0.95). The critical value of Studentized Range was 3.732, and the minimum significant difference was 6.5232 (Table 6).

Table 6

Tukey's Studentized Range (HSD) Test for variable: SCORE

TRT Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
TRT4 - TRT2	-3.982	2.542	9.065	
TRT4 - TRT3	-3.815	2.708	9.232	
TRT4 - CNTL	9.518	16.042	22.565	***
TRT2 - TRT4	-9.065	-2.542	3.982	
TRT2 - TRT3	-6.357	0.167	6.690	
TRT2 - CNTL	6.977	13.500	20.023	***
TRT3 - TRT4	-9.232	-2.708	3.815	
TRT3 - TRT2	-6.690	-0.167	6.357	
TRT3 - CNTL	6.810	13.333	19.857	***
CNTL - TRT4	-22.565	-16.042	-9.518	***
CNTL - TRT2	-20.023	-13.500	-6.977	***
CNTL - TRT3	-19.857	-13.333	-6.810	***

Alpha= 0.05 Confidence= 0.95 df= 63 MSE= 73.32302
Critical Value of Studentized Range= 3.732
Minimum Significant Difference= 6.5232
Comparisons significant at the 0.05 level are indicated by '***'.

Table 6 shows the differences between the means for all the comparisons as well as their lower and upper confidence limit. A review of Table 6 reveals that the only significant comparisons at p.> 0.05 were those

between the Control condition and the three treatment conditions. All the other pairwise comparisons--TRT4-TRT2 = 2.542, TRT4-TRT3 = 2.708, TRT2-TRT4 = 2.542, TRT2-TRT3 = 0.167, TRT3-TRT4 = -2708, and TRT3-TRT2 = 0.167--were not significant. The null hypothesis of no difference was retained.

These findings suggest that the addition of the conjugation and background information reading supports (individually or in combination) to the vocabulary reading support, did not contribute to a significant increase in the reading comprehension as evidenced by the recall protocol scores. In fact, the addition of the conjugation reading support to the glossary support (treatment III) resulted in lower recall scores.

Data from Simultaneous Reading/Recalling Measures

In all, four bits of information were collected by the computer program for each text read by each subject. This data collection was unobtrusive and simultaneous with the experimental task. These measures included:

1. Overall Experiment Time: The overall amount of time (in minutes) the subject spent reading and recalling the four experimental texts, consulting/accessing/reviewing the different reading supports provided by the computer.
2. Reading Time: The amount of time the subject spent reading each of the four experimental texts.
3. Recall Time: The amount of time the subject spent recalling and typing each of the four experimental texts.
4. Number and Type of Reading Supports Accessed: The number of times each subject accessed each of the reading supports provided for consultation.

Time on Task

The computer recorded the reading and recalling time for each text. Overall means and standard deviations for the total experiment time as well as the reading and recalling time by Treatment are presented in Tables 7, 9, 10. Also presented in Tables 8, 11, 12, 13, 14 are the correlation coefficient indexes for the correlations between overall time, reading time, and recalling time, on one hand, and the recall scores on the other.

Table 7
Means and Standard Deviations for the Total Time and Total Score Variables

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
TOTTIME	24	90.6667	16.9210	2176.0	51.0000	119.0
TOTSCORE	24	162.9	66.6896	3909.0	62.0000	270.0

A Pearson product-moment correlation procedure produced an insignificant correlation coefficient of r=0.0061 (Table 8) between the two variables.

Table 8
Correlation Analysis
2 'VAR' Variables: TOTTIME TOTSCORE

Pearson Correlation Coefficients/Prob >|R| under Ho:Rho=0/N = 24

	TOTTIME	TOTSCORE
TOTTIME	1.00000 0.0	-0.00601 0.9778
TOTSCORE	-0.00601 0.9778	1.00000 0.0

The no significant finding suggests that total time readers spend reading and recalling the four texts is not a good predictor of their comprehension score. Table 9 shows the means and standard deviations for the Control (no access) condition and the three Treatment conditions. An examination of the table revealed no significant differences between the reading time means for the three treatment conditions and the control condition. Differences of 2.7083 (19.2%), 0.9583 (6%), and 4.125 (29.4%) minutes were detected between the reading time mean of the no access condition and Treatments II, III, and IV, respectively.

Table 9
Reading Time for Texts by Treatment

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RDGTIME 1	24	14.0417	4.0052	337.0	7.0000	21.0000
RDGTIME 2	24	16.7500	5.9363	402.0	5.0000	35.000
RDGTIME 3	24	15.0000	7.0403	360.0	3.0000	40.0000
RDGTIME 4	24	18.1667	8.8792	436.0	8.0000	39.0000

An inspection of Table 10 shows no significant differences between the recall time means of the control and the treatment conditions. In fact, the means of recall time for treatment conditions III and IV (μ= 5.9583, μ=6.5417) are smaller than that of the Control condition (μ=7.0417) which translates into decreases of 2 and 7 percentage points. This finding is not surprising given the fact that reading time was longer for the two treatment conditions under consideration. Recall time of Treatment 2 texts increased by about 2 percentage points.

Table 10
Recall Time for Texts by Treatment

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RCLTIME 1	24	7.0417	3.5932	169.0	2.0000	15.0000
RCLTIME 2	24	7.1667	4.8335	172.0	3.0000	28.0000
RCLTIME 3	24	5.9583	2.5449	143.0	2.0000	15.0000
RCLTIME 4	24	6.5417	2.2063	157.0	3.0000	13.0000

As noted in Tables 11, 12, 13, and 14, reading times for the subjects in the access to reading supports conditions (μ=16.7500, μ=15.0000, μ=18.1667, for conditions 2, 3, & 4, respectively) were longer than the reading time for the no access (Control condition, μ=14.0417). This may have been time spent comprehending the text, accessing the reading supports, or a combination of both. Because the access condition subjects also scored higher on the recall measure, the question becomes: can the increase in learning be attributable to the increase in time? These data, when correlated with the mean recall scores produced low positive correlation coefficients (r=-0.12632 for Control, r=-0.40087 for Treatment I, r=0.26759 for Treatment III, and r=0.4396 for Treatment IV) that were not significant at the 0.05 level of significance, except for Treatment conditions II and IV that showed moderate negative correlation with the recall score. These findings suggest that reading time is not a good predictor of comprehension scores.

Table 11
Simple Statistics and Correlation Analysis
3 'VAR' Variables: RDGTIME RCLTIME SCORE

TRT=1

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RDGTIME	24	14.0417	4.0052	337.0	7.0000	21.0000
RCLTIME	24	7.0417	3.5932	169.0	2.0000	15.0000
SCORE	24	30.0000	19.4221	720.0	0	62.0000

Pearson Correlation Coefficients/ Prob >|R| under Ho:Rho=0/N =24

	RDGTIME	RCLTIME	SCORE
RDGTIME	1.00000	0.03311	-0.12632
	0.0	0.8779	0.5564
RCLTIME	0.03311	1.00000	0.20372
	0.8779	0.0	0.3397
SCORE	-0.12632	0.20372	1.00000
	0.5564	0.3397	0.0

Table 12
Simple Statistics and Correlation Analysis
3 'VAR' Variables: RDGTIME RCLTIME SCORE

TRT=2

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RDGTIME	24	16.7500	5.9363	402.0	5.0000	35.0000
RCLTIME	24	7.1667	4.8335	172.0	3.0000	28.0000
SCORE	24	43.5000	21.4679	1044.0	8.0000	76.0000

Pearson Correlation Coefficients/Prob > R| under Ho: Rho=0/N = 24

	RDGTIME	RCLTIME	SCORE
RDGTIME	1.00000	0.06364	-0.40087
	0.0	0.7677	0.0522
RCLTIME	0.06364	1.00000	-0.28409
	0.7677	0.0	0.1785
SCORE	-0.40087	-0.28409	1.00000
	0.0522	0.1785	0.0

Table 13
Simple Statistics and Correlation Analysis
3 'VAR' Variables: RDGTIME RCLTIME SCORE

TRT=3

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RDGTIME	24	15.0000	7.0403	360.0	3.0000	40.0000
RCLTIME	24	5.9583	2.5449	143.0	2.0000	15.0000
SCORE	24	43.3333	17.0591	1040.0	19.0000	72.0000

Pearson Correlation Coefficients/Prob >|R| under Ho:Rho=0/N = 24

	RDGTIME	RCLTIME	SCORE
RDGTIME	1.00000	0.23539	0.26753
	0.0	0.2682	0.2063
RCLTIME	0.23539	1.00000	0.24670
	0.2682	0.0	0.2452
SCORE	0.26753	0.24670	1.00000
	0.2063	0.2452	0.0

Table 14
Simple Statistics and Correlation Analysis
3 'VAR' Variables: RDGTIME RCLTIME SCORE

TRT=4

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RDGTIME	24	18.1667	8.8792	436.0	8.0000	39.0000
RCLTIME	24	6.5417	2.2063	157.0	3.0000	13.0000
SCORE	24	46.0417	16.0393	1105.0	20.0000	74.0000

Pearson Correlation Coefficients/Prob >|R| under Ho:Rho=0 /N =24

	RDGTIME	RCLTIME	SCORE
RDGTIME	1.00000	-0.25338	-0.43936
	0.0	0.2322	0.0317
RCLTIME	-0.25338	1.00000	0.44041
	0.2322	0.0	0.0312
SCORE	-0.43936	0.44041	1.00000
	0.0317	0.0312	0.0

A Pearson product-moment correlation procedure produced correlations of r=0.20372, r=-0.28409, r=0.24670, and r=0.44041 between recall time of text by treatment and overall reading comprehension scores Tables 11, 12, 13, and 14). Except for a moderate negative correlation between the two variables in the Treatments II and IV, the other correlations were not significant at the 0.05 level of significance. These findings suggest that recall time accounts for an insignificant percentage of variance in the comprehension score and led to the retention of the null hypothesis.

To determine the extent to which subjects in the study selected reading supports and which, if any, of the supports was preferred, the computer recorded the number of requests for each support. The results were tabulated and are displayed in Tables 15, 16, and 17. Overall, readers requested a mean of 6.1677, 7.9167, and 8.2197 glossary reading supports in Treatments II, III, and IV, respectively. The means for conjugation supports selected were 1.00 for Treatment III, and 0.958 for Treatment IV. The subjects requested a mean of 1.167 background information supports in Treatment IV. These data reveal that subjects given the opportunity to do so, independently chose to select reading supports mediated by the computer and that across all three texts in which the supports were available, subjects chose the glossary support significantly more often than the other two supports. Future researchers could use this information to test for effects by manipulating the treatments or text and observing the effects on subjects reading behavior as indicated by their selection of reading supports.

Another analysis investigated the possible relationship between the frequency of use of reading supports and reading comprehension. A Pearson product-moment procedure produced the correlation coefficients of r=0.22400, r=0.20920, and r=0.14720, p=<0.05, between frequency of use of the glossary reading support and recall scores when used in Treatments II, III and IV, respectively (Tables 15, 16, and 17). This finding suggest that there is no significant relationship between frequency of use of the glossary support and reading comprehension scores and led to the retention of the null hypothesis. The low positive correlations in the three treatment conditions indicate that subjects' frequency of use of the support accounted, at the most, for 5% of the variance in their reading comprehension scores. This also suggests students' frequency of use of the glossary support is not a good predictor of their reading comprehension.

Table 15
Simple Statistics and Pearson Product-Moment Correlation between Number of Times Supports were Used and Test Score by Treatment

TRT=2

2 'VAR' Variables: VOC SCORE

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
VOC	24	6.1667	3.6076	148.0	0	13.0000
VOCCON	0	.	.	.	.	.
VOCCONBK	0	.	.	.	.	.
SCORE	24	43.5000	21.4679	1044.0	8.0000	76.0000

Pearson Correlation Coefficients

	VOC	SCORE
VOC	1.00000	0.22400
SCORE	0.22400	1.00000

Table 16

Simple StatisticsPearson Product-Moment Correlation between Number of Times Supports were Used and Test Score by Treatment

TRT=3

3 'VAR' Variables:		VOC	VOCCON	SCORE	
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
VOC	24	7.9167	4.3331	190.0	1.0000	21.0000
VOCCON	24	1.0000	0.9325	24.0000	0	3.0000
VOCCONBK	0	.	.	.	.	.
SCORE	24	43.3333	17.0591	1040.0	19.0000	72.0000

Pearson Correlation Coefficients

	VOC	VOCCON	SCORE
VOC	1.00000	-0.17217	0.20920
VOCCON	-0.17217	1.00000	-0.07926
SCORE	0.20920	-0.07926	1.00000

Table 17

Simple Statistics and Pearson Product-Moment Correlation between Number of Times Supports were Used and Test Score by Treatment

TRT=4

4 'VAR' Variables:		VOC	VOCCON	VOCCONBK	SCORE	
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
VOC	24	8.2917	5.6297	199.0	1.0000	30.0000
VOCCON	24	0.9583	0.9991	23.0000	0	4.0000
VOCCONBK	24	1.1667	1.2394	28.0000	0	5.0000
SCORE	24	46.0417	16.0393	1105.0	20.0000	74.0000

Pearson Correlation Coefficients / Prob >|R| under Ho: Rho=0/N=24

	VOC	VOCCON	VOCCONBK	SCORE
VOC	1.00000	0.37329	-0.05089	0.14720
VOCCON	0.37329	1.00000	0.04096	-0.22508
VOCCONBK	-0.05089	0.04096	1.00000	0.17241
SCORE	0.14720	-0.22508	0.17241	1.00000

A Pearson Product-moment procedure produced the correlation coefficients of r=-0.07926 and r=-0.22508, $p>0.05$ between the background reading support and recall

scores when used in Treatment II and IV (Tables 16, and 17). This finding revealed that there is no significant relationship between frequency of use of the background information support and reading comprehension scores. The low negative correlations in the two treatment conditions (III and IV) indicate that subjects' frequency of use of the conjugation support accounts for a negligible percentage of the variance in readers' reading comprehension scores. Evidently, the number of times the conjugation reading support is accessed or consulted is not a significant indicator of how well students are able to recall texts.

A Pearson Product-moment procedure produced the correlation coefficients of $r=0.17241$, $p>0.05$ between the background reading support and recall scores when used in Treatment III (Table 17). This finding suggests that there is no significant relationship between frequency of use of the background reading support and reading comprehension scores. The positive low correlation indicates that subjects' frequency of use of the background support accounts for a minute percentage of the variance in readers' reading comprehension scores. This suggests that students' frequency of use of the background support is not a good predictor of their reading comprehension.

Discussion

The purpose of the present study was to investigate the effects of computer-mediated reading supports on the comprehension and the reading behavior of college beginning Arabic learners. Findings and conclusion will

be discussed in two sections:(a) reading comprehension, and (b) simultaneous measures.

Reading Comprehension

Previous research in L1 indicates that comprehension scores should increase when readers read microtexts that provided reading supports of the types available for reader in this study. According to first language research, this increase in comprehension score is the function of the technological attributes of the computer that permit deeper and more interactive flow of information between the reader and the text.

In this study, it was expected that subjects with access to computer-mediated reading supports would have higher recall scores than when not. It was also expected that the combination of two or more of the reading supports (Treatments III and IV) would result in even higher recall scores.

The analysis of data in the present study detected significant differences between the Control condition and the three treatment conditions. Readers with access to computer-mediated reading supports scored higher on the recall protocol measure (Treatment II, μ=43.5000, Treatment III, μ=43.3333, and Treatment IV, μ=46.0417) than when no reading supports were available (Control, μ=30.000). The analysis, however, did not detect significant differences between the means of the three treatment conditions ($\mu 3-\mu 2 = -0.167$; $\mu 4-\mu 2 = 2.542$, and $\mu 4-\mu 3 = 2.708$). The minimum significant difference was 6.523. The results of the post-hoc pairwise comparisons indicated that generally, when subjects have access to three types of reading supports, individually, or in combination, they score higher than when they read texts

with no access to reading supports. This analysis, however, did not detect significant differences between the means scores of the three treatment conditions. This finding suggests that the availability of more than one reading support at a time did not significantly affect the reading comprehension of the subjects.

Despite the nonsignificance finding, the means obtained in the pairwise comparisons lend partial support to the expectation stated above. These means indicated that on the average, the mean scores of the treatment conditions increased by about 13.5 points (from μ=30.000 for the control to μ=43.500 for treatment II). However, a decrease of 0.167 was observed with the addition of the conjugation reading support in Treatment III. Insignificant differences of 2.541 and 2.708 points were also observed between Treatments II and III on the one hand, and Treatment IV, on the other (μ=46.041 vs μ=43.500, and μ=46.041 vs μ=43.333, respectively).

The most important observation, however, is the significant difference between the mean of the Control condition and that of Treatment II. An increase of 13.500 points was observed as well as an increase in the minimum score (from 0 to 8), the maximum (from 62 to 76) and the sum (from 720 to 1044).

Further inspection of the results also revealed that despite that fact that the minimum recall score increased with the addition of the conjugation reading support (from 8 to 19), the maximum score fell from 76.00 to 72.00. Moreover, the sum of scores for all students was less for Treatment III recalls (1040.00 vs. 1044.00 for Treatment II). With the addition of the

background information reading support to the other two (Treatment IV, the sum of scores went up (1105.00) as well as minimum and maximum scores (20.00 and 74.00) respectively. The maximum score obtained (74.00), however, was less than that obtained when the vocabulary was the only support available (76.00).

Overall, these findings suggest, at least for this sample, that the vocabulary knowledge is the primary contributor to reading comprehension and that background information played an insignificant role in enhancing readers' comprehension during independent reading. Verb conjugation was not a contributing factor in the reading comprehension of beginning college-level readers of Arabic irrespective of which text they read. These results further suggest that the role both grammatical knowledge and background knowledge play in reading comprehension needs to be clarified.

An explanation for this finding of insignificant differences may come from the simultaneous data recorded by the computer program during the reading activity. Generally speaking, all subjects consulted the glossary (Treatment II) at least once with every text, except for one subject who failed to access it once while reading text 1. In all, subjects used the vocabulary reading support (Treatment II) 538 times, an average of 22.41 times per subject, and an average of 7.47 per text.

Treatment III, in which the reading support, the past and present tense conjugation of selected verbs, was provided in combination with the glossary (Treatment II), was accessed only 47 times by all 24 subjects. Fifty percent of the subjects (12/24) consulted the

conjugation reading support during the independent reading of Text 1.

When a third reading support (background information) was added to the other two reading supports (Treatment IV), only 6 subjects (25%) opted to access it while reading Text 1. While reading Text 2, only 5 subjects (20.8%) chose to access the information provided for them. Only 4 (16.6%) subjects consulted the background information reading support while reading Text 3 and no one (0%) accessed it while reading Text 4.

In sum, subjects' low frequency of use of the verb conjugation and background information reading supports, whether because of unfamiliarity with their use, the perceived insignificance of their role in improving reading comprehension, or because of subjects' inexperience in managing the contingencies of their reading and study, may account for the no differential effects of treatment conditions on reading comprehension.

In summary, the data in the four-way mixed factor ANOVA and the subsequent pairwise comparisons demonstrated that the computer-mediated reading supports chosen for the study did facilitate the reading comprehension of the four texts.

The results of this study can be interpreted in light of the metacognitive theory and technological attributes of the computer which may be employed to mediate text. It appears that beginning readers of AFL are lacking or are less skilled in monitoring their comprehension and in the use of study and learning strategies. The findings also suggest that they benefited from situating them in an expert's environment that enabled them to

interact more overtly with text. Moreover, using the computer in the access to the reading supports conditions, may have encouraged the readers to process more deeply and more actively the meaning of the text by structuring their exposure to designated reading supports. This interpretation suggests that the computer might provide unique opportunities to manage readers' interaction with the text during independent reading. In particular, the ease with which readers of computer-mediated texts can access word meanings and background and other information may affect their propensity to seek out the meanings of difficult words and expand their repertoire of general and specific prior knowledge. Increased attention to difficult words during independent reading may lead to an increase in a reader's vocabulary knowledge which may in turn, increase the comprehension of texts. In addition, expanding a reader's knowledge base may enrich his or her cognitive repertoire and make him or her less dependent on syntactic and lexical knowledge in the interpretation and reconstruction of text. In interpreting the findings of their study, Reinking and Schreiner (1985) have noted that the computer may have helped readers monitor their comprehension by externalizing processing variables which some readers ordinarily ignore.

The overall findings of this study support the conclusion that computers may enhance comprehension when they are used purposefully to effect more active processing of text.

Simultaneous Measures

Additional data analysis produced no significant correlation coefficients between reading time and recalling time on the one hand, and reading comprehension scores, on the other. The insignificant low correlation between these variables indicated that reading and recalling time, whether correlated with the recall scores separately, or in combination (total score), accounted for a very low percentage of the variance in subjects' reading comprehension scores. This finding suggests that increases in reading and recalling time alone do not account for increases in comprehension when the computer is used to provide readers with options for assistance. In other words, the time subjects took to finish the experimental task was not a good indicator of their ability to comprehend. One could argue that increases in comprehension under the conditions of this study are more likely to be due to deeper or more efficient cognitive processing than prolonged exposure to the text.

The analysis of data using both the Dunnett procedure and Tukey's Studentized Range (HSD) indicates that the glossary reading support had the greatest and most significant effect on reading comprehension. This finding suggests that, for this sample, vocabulary knowledge was the primary contributor to comprehension enhancement.

These results also suggest that the comprehension of a particular set of informative reading texts can be affected by variations in reading supports mediated by the computer. It is not clear, however, whether this effect is more a function of using the computer to

control readers' exposure to reading supports or simply making reading supports available for reader selection. A more definitive answer could be obtained by manipulating the locus of control (computer-controlled vs. reader-controlled).

A consideration which may have influenced recall scores is that reading supports provided by the computer may have been unnecessary or unused by many subjects. Descriptive data from the simultaneous measures support the second interpretation. Some readers possessing perhaps well-developed metacognitive strategies may have found the manipulations unnecessary to the management of their own processing. Salomon (1979) has reported evidence that the performance of the more cognitively skillful is depressed when they are forced to engage in external processing. Other readers, may have been overwhelmed by the reading supports (especially verb conjugation) or simply unaware of how to use them to enhance their own comprehension. Equally possible is that reading texts on the computer accompanied by unfamiliar reading supports may have distracted some students from focusing on the text's meaning.

The findings reported in this study suggest that beginning foreign language readers will independently select reading supports mediated by the computer in the course of their reading and study. Evidence in the present study suggests that beginning AFL readers may be prompted to interact with the meaning of informative texts when the computer is used to mediate a selected set of reading supports. Simultaneous data collected by the computer during the reading of texts in the access conditions, indicated that these readers attempted to

enhance comprehension by freely selecting computer-mediated reading supports. Overall, all subjects in the present study used one or more of the computer-mediated reading supports, individually or in combinations. In all, the students used the three types of reading supports a total of 612 times, the minimum being 0 and the maximum 30. For reasons which are difficult to determine from the present study, subjects requested vocabulary reading support significantly more often than both the background information and the verb conjugation supports.

These figures give us an idea about which of the reading supports was perceived by the readers as more important and more facilitative to the process of reading comprehension. Readers' direct oral comments to the researcher as well as their comments in their recall protocols and the unsolicited remarks on the back of the questionnaire form, all point to the fact that most of the subjects in this study perceived vocabulary knowledge as the most important factor in facilitating their task of text reconstruction. Thus, an important factor in the effective use of computer-mediated aid may be the reader's awareness of what reading supports might be useful in enhancing text comprehension. This may be especially important for weak and beginning readers who do not possess knowledge of strategies and often are not aware of when and how to apply knowledge they possess. It if safe to argue that computer-mediated aid could be of greater value to beginning and weak readers when they are reading more difficult texts, especially if the supports are easily available via the computer.

The fewer selections for conjugation and background information is hard to explain in light of the theoretical and empirical evidence pointing to their importance as factors in improving comprehension. The more choices for vocabulary meanings may have been due to subjects' perception that vocabulary plays a primary role in text comprehension

Implications for Further Research and Pedagogy

Theoretical Implications

It is apparent, within the realm of second-language acquisition, that an adequate theory of reading comprehension is a prerequisite for the development and improvement of educational practices. This, according to Kamil, Langer, & Shanahan (1985) can be achieved "through the application of knowledge derived from careful research" (p. ix). Bernhardt (1991) concurs and notes that "[P]rincipled language instruction evolves from a sound knowledge of learners as learners, of learners in the act of accomplishing language tasks...." (p. 224). Bernhardt's model of L2 text comprehension is an example of a learning and comprehension theory that is based on empirical research. More research, however, is needed in different languages and different proficiency levels to verify and substantiate current theory. This study is an attempt in this direction. In addition, more research is needed to investigate readers' cognitive processes under different conditions while manipulating as many variables as possible. This direction must also involve the utilization of multiple measures that are both qualitative and quantitative in nature. After all, reading comprehension and language

learning, in general, is a multifaceted process that no single research paradigm can encompass. The descriptive data from the simultaneous measures recorded by the computer program, complemented the quantitative data generated in this study.

When the reading protocol is used as a measure for assessing reading comprehension, different scoring systems should also be investigated to find the optimal means by which to analyze recall of written texts. This entails manipulating the variable of scoring system to investigate which system might best demonstrate recall. The present researcher (Aweiss, 1993b) has proposed a scoring system that accounts for the cognitive constructive activities involved in reading comprehension, a system that rewards the reader for attempts to summarize, paraphrase, assimilate, and integrate information from the different segments of the text. The proposed system also rewards the reader for relevant elaborations and comments and for the use of prior knowledge.

Replication of this study, in numerous ways, is called for to further investigate computer-mediated reading supports. The study could be replicated with different population of learners and across languages--more advanced--for example. The population of this study was limited to second and third quarter university Arabic learners.

In addition to varying the subjects, the study needs to be replicated using different texts. Because of restrictions imposed by the recall protocol procedures, the readings were short. Will these same findings hold when longer text are read? What will happen if the text

is easier of more difficult, the topics more or less interesting. These variables were controlled in this experiment. In order to increase generalizability of findings, however, these variables must also be manipulated.

Further research that controls for the factor of type of text (narrative vs. expository) is needed to clarify the findings of this study. In this study, the type of text variable was not controlled.

Refining the techniques and procedures in accordance with the most recent findings in cognitive theory and advances in computer technology may be a beginning point for continued research. In addition, some of the unclear or puzzling findings may be further clarified by careful replication with controlled variations in procedure.

One area of research could involve differential locus of control. An issue that has emerged from the studies investigating computer-mediated texts is the degree to which the reader or the computer controls the assistance provided by the computer. Unlike conventional texts, for example, computer-mediated texts can restrict a reader's access to a text based on contingencies specified in computer program. Despite the encouraging results for computer-mediated reading supports, a number studies suggest that students are often not good judges of the type and amount of instruction that they need to improve their learning (Belland et al., 1985; Carrier, 1984; Gay, 1986; Steinberg, 1977). Thus, the question of reader versus computer control for optimal text comprehension should be researched further.

The present study also generated little evidence that computer-mediated text transfers to non-experimental

passages or affects general comprehension ability. There is some subjective evidence that readers exposed to the access to reading supports treatment condition did transfer some of the sensitivities highlighted in this condition to other reading. When informally questioned after the experiment, several subjects responded favorably to a question about whether or not the treatment helped them read better. Several subjects spontaneously suggested that the experience helped them think more about what they read and made them aware of the strategies and factors that impact reading comprehension. Follow up studies could explore the possibility of transfer effects on more subtle measures of comprehension.

Further research on the effects of computer-mediated reading supports on the comprehension of beginning readers should attempt to determine whether the types of supports provided in this study are best for all second-language learners. Such research could investigate, for example, how learners at different levels of proficiency benefit from providing them with means of enhancing their comprehension.

Pedagogical Implications

The most evident pedagogical implications are perhaps those for novice learners. Those learners are at a disadvantage when they read independently. They normally lack the skill of guessing the meaning of words from context, use their prior knowledge, or utilize the different semantic and syntactic clues in the text. They may even be unable or unaware of such study and comprehension strategies. Putting such readers in an

environment where they can benefit from conditions available only to skilled and advanced readers, would certainly enhance their comprehension and alleviate much of the cognitive load placed on them.

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