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Effects of Visible and Invisible Hyperlinks on Vocabulary Acquisition and Reading Comprehension for High- and Average-Foreign Language Achievers [*]

Ofelia R. NIKOLOVA

Southern Illinois University at Carbondale, United States

Abstract: *This study investigated the effects of visible and invisible links for annotated words in a computer module for learning French on the vocabulary acquisition and reading comprehension of two types of students – high- and average-achievers. Two hundred and sixty four second-semester students of French were identified as high- or average-achievers. Each type of students was then randomly assigned to two groups – with visible or invisible hyperlinks. All students were instructed to read a short passage in French (181 words) for general comprehension and allowed to consult the annotated words (made visible by bold face for the visible links group) as much as they needed. The students took a vocabulary pretest and an immediate and delayed (two weeks) vocabulary and reading comprehension posttest. The results of the study showed that average-achievers benefited more from the visible links for vocabulary acquisition and reading comprehension than high-achievers. The results are discussed in light of second language acquisition and gifted-student theories and suggestions for future research are made.*

- 1. Introduction
- 2. Review of related literature
- 3. Hypotheses
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- 5. Discussion
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1. Introduction

The present study reports data from an investigation of the effects of visible and invisible hyperlinks in a French text on the vocabulary recall and reading comprehension of average- and high-achieving students, learning French as a foreign language. This investigation sought

to determine which type of learner benefited more from marked or respectively unmarked annotated words in a foreign language text. A comparison was made between the scores of four groups of learners (average-achievers with visible and invisible links and high-achievers with visible and invisible links) on their immediate and two-week delayed vocabulary recall and reading comprehension tests.

2. Review of related literature

2.1. Vocabulary acquisition

Recently, vocabulary acquisition has been one of the most actively researched topics in second language acquisition (SLA) due mainly to the impact vocabulary has on successful communication ([Levelt89] ; [Meara95]). The topic is however ridden with controversy. Some researchers [Bogaards01] accuse the field of lacking rigor in its very definition of the term “word”. They also challenge the notion of vocabulary “learning” claiming that learning of essentially polysemic lexical units is a multi-step process and requires more than one exposure to the unit, leaving the learner most of the time in a state between full ignorance and complete knowledge. At the same time, the bulk of the research done in the field involves experiments, which expose the learners to few occurrences of the target lexical items and use the widely-accepted layman’s term of “word” ([ChunPlass96a] ; [DeRidder02] ; [HulstijnHollander96]). Realizing the complexity of the issue, in the present paper we have followed the traditional pattern of experimental set up to allow for comparability between the current study and previous similar studies as well as in order to facilitate operationalization of the terms. We are aware though that vocabulary learning or recall in the context of this article applies only to the meaning of the target words encountered in the text and does not necessarily involve complete knowledge of the lexical item with all its possible meanings.

2.2. Vocabulary acquisition and reading comprehension

Foreign language vocabulary also plays an important role in achieving high-level reading ability and enhancing comprehension ([AndersonFreebody81] ; [Markham89] ; [SegalowiczWatson95]). It is necessary to point out that the relationship between vocabulary acquisition and reading comprehension is not a completely straightforward one. Reading comprehension requires a host of interactive variables, which operate in a complicated unison [ChunPlass97]. Reading is thus dependent not only on vocabulary knowledge, but also on world / background knowledge, synthesis and evaluation skills and strategies, and metacognitive knowledge and skill monitoring. The relationship between vocabulary knowledge and reading albeit not exclusive remains an important one. Even though some recent studies have been published which challenge this role ([Chodkiewicz01] ; [LauferNation01]), it is widely believed that reading is an important source of vocabulary acquisition both in L1 and L2 (see discussions in [Bogaards01] ; [Krashen89] ; [Watanabe97]).

2.3. Modalities of vocabulary acquisition

A variety of modalities of vocabulary acquisition have been the object of research in the field of SLA: negotiation of meaning, incidental learning, guessing from context, use of cognates,

etc. Some of these modalities, such as negotiation of meaning, are realized through exchange of messages, others, such as incidental learning while reading do not require an overt interactivity of the learning task. Negotiation of meaning has been found in recent research to be an excellent vocabulary acquisition tool. Its logistics, however, are more complicated than those of reading since it requires the participation of a partner. Reading, on the other hand, has the advantage of being an activity which learners can carry out on their own.

Frequently, vocabulary acquisition while reading occurs in an incidental way and is attributed to the learners' guesses from the context in which the vocabulary item occurs [Krashen89]. Even though incidental learning while reading is relatively successful (for a divergent opinion see [Chodkiewicz01]), many researchers report data showing that its efficiency could be enhanced further by rendering the text more comprehensible through usage of glosses or a dictionary, for example ([Hulstijn92] ; [Watanabe97]). Numerous articles concerned with the controversy between guessing from context and use of a dictionary or glosses in L2 acquisition provide data in favor of dictionary / gloss use in addition to vocabulary embedded in a natural context ([AlSeghayer01] ; [Groot00] ; [Hulstijn00] ; [HulstijnHollander96] ; [Knight94] ; [Krantz91] ; [Lomicka98] ; [LuppeskuDay93] ; [LymanHagerDavis93] ; [LymanHagerDavis96] ; [Summers88]). Guessing is particularly successful if the word to be learned is relatively frequently encountered in the student reading and when students have a sufficient enough background to understand the context. In the case of rarely occurring, low-frequency words and beginner students, consulting dictionaries / glosses is particularly helpful. In addition, it is sometimes the case that even a correct guess does not necessarily ensure acquisition. It is the contention of some researchers [MondriaWitdeBoer91] that learners who guess any of the words correctly do not pay sufficient attention to the link between form and meaning in the learning stage. This lack of engagement in deeper processing hinders the learning of the word.

2.4. The role of different annotations for vocabulary acquisition

In the present study we investigated vocabulary acquisition in a media environment provided with glosses. Several fundamental research questions are posed regarding this issue. They include the effectiveness of glosses via different media for vocabulary acquisition, the attitude of students toward paper vs computer dictionaries / glosses, the gloss density in a text, the richness of glosses (the extent and type of information included in them), the student look-up preferences, etc. ([AlSeghayer01] ; [AustKellyRoby93] ; [ChunPlass96b] ; [DavisLymanHager97] ; [Groot00] ; [Hulstijn00] ; [KostFossLenzini99] ; [LauferHill00] ; [Lomicka98] ; [LymanHagerDavis93] ; [LymanHagerDavis96] ; [Nagata99] ; [PlassChunMayer98] ; [Roby99] ; [Siribodhi95] ; [YoshiiFlaitz02]).

Text, sound, pictures, and video have all been scrutinized and compared as possible ways of annotating words. No definitive answer has been proposed, but image-based annotations and combination of image-based and text options seem to have advantage over text only annotations for L2 vocabulary acquisition ([AlSeghayer01] ; [ChunPlass96b] ; [KostFossLenzini99] ; [PlassChunMayer98] ; [Siribodhi95] ; [YoshiiFlaitz02]).

Recent studies have turned toward learner preferences based on information from student look-up behavior. Results point in the direction of a variety of presentation of the glosses in order to satisfy the differences in student preferences ([LauferHill00] ; [Lomicka98] ;

[LymanHagerDavis96] ; [PlassChunMayer98]). Some researchers [Nagata99] suggest interactive computerized glosses as a way of enhancing second language vocabulary acquisition.

One question, however, remains barely touched upon when glosses are concerned. As opposed to their contents (rich, extended, interactive, textual, image- or text-based, etc.), their graphic presentation on the computer screen has been relatively little investigated. As Isabelle De Ridder points out:

[...] although many things have been said about what should appear on the screen to obtain better results in language learning, how these features should appear to the learner-user is still under investigation. The how question is often considered to be a simple design question, independent of the learning process. But is this truly the case? ([DeRidder02]: 123).

As De Ridder goes on, referring to [Frenckner90], research has shown many times over that presentation is an integral part of the learning environment with an important effect on learner achievements.

The present study is a follow-up on the study by De Ridder, utilizing a very similar design, but asking different questions. In her study De Ridder compared two groups of Flemish students learning French in a university in Belgium. Both groups read the same text presented on a computer screen with some of the words annotated with text glosses. The first group had all annotated words "marked" on the computer screen – they were typed in a different color (blue) and underlined. For the second group, there was no external indication that the words were annotated. De Ridder compared the participants' reading time, their vocabulary learning, and their reading comprehension. The study concluded that students presented with marked glossed words are more willing to consult their meaning, but this does not slow down their reading process. The more frequent clicking does not affect vocabulary learning neither does it influence reading comprehension.

2.5. High-achievers vs average-achievers

In our study, we were interested in the performance of high-achieving vs average-achieving students in foreign language classes. Even though there is no complete correlation between levels of achievement and linguistic giftedness [Winner97], high ability is frequently linked to excellence in performance. It was, therefore, important for us to ascertain some of the qualities that academically and linguistically gifted students are believed to exhibit. According to Garfinkel and Prentice [GarfinkelPrentice85] some of them are the ability to deal with large amounts of information and extraordinary retentiveness, advanced comprehension, high levels of language development and verbal ability, exceptional information processing qualities, flexible and rapid thought processes, abstract thinking, originality, and persistently goal oriented behavior. Bartz [Bartz82] adds some additional characteristics typical for the high-ability foreign language learner. They include field independence, ambiguity tolerance, balanced generalization, extroversion, metacognitive awareness, risk-taking, good guessing strategies, active approach toward the foreign language, attention to both form and meaning, easy and early adjustment to a new language, and empathy.

Independence and metacognitive awareness were the most important features for our study since we were looking at two different conditions, which basically differed in the amount of external pointers they offered the learners. In the present study, we identified our high-achievers on the basis of their grades in French.

Taking into account the fundamental differences in metacognitive awareness, and need or lack thereof of external pointers in the learning process between average and high-ability students, this research set up to investigate the effects of marked or unmarked glosses on vocabulary acquisition and reading comprehension for average and high-achievers. We believed that even though in a general population the effect of visibility / invisibility of glosses may have been lost, it is quite possible that it will show in a comparison between students of different abilities / achievement levels.

3. Hypotheses

The purpose of the study described in this paper was a comparison between two types of learners (average and high-achievers) reading a French text presented on a computer screen, where text annotations (Bulgarian translation) were linked to some words in the text. Both types of students were further divided into groups according to the type of links their text contained – visible (marked in bold face) or invisible (unmarked). The dependent variables - recall of vocabulary and text comprehension - were compared for the four groups.

The hypotheses, which the study sought to test, were stated as follows:

- 1) Immediate recall of vocabulary will be the same for high-achievers using visible links and for high-achievers using invisible links and better for average-achievers using visible links than for average-achievers using invisible links.
- 2) Delayed recall of vocabulary will be the same for high-achievers using visible links and for high-achievers using invisible links and better for average-achievers using visible links than for average-achievers using invisible links.
- 3) Immediate reading comprehension will be the same for high-achievers using visible links and for high-achievers using invisible links and better for average-achievers using visible links than for average-achievers using invisible links.
- 4) Delayed reading comprehension will be the same for high-achievers using visible links and for high-achievers using invisible links and better for average-achievers using visible links than for average-achievers using invisible links.

The above-formulated hypotheses were based on results from studies discussed earlier. Given that the average-achieving students had an external pointer to the annotated words and that they were more likely to rely upon external pointers, we deduced that they would also be more likely to benefit from the visible links in the annotated text.

4. Methodology

4.1. Subjects and design

The target population for subject recruitment was all students from the second semester, first year French class at a large university in Bulgaria. The sample of subjects participating in the study was formed by all the students who volunteered to do so. Out of a target population of 289 students, 264 participated in the study. All students were native speakers of Bulgarian.

This study followed a 2x2 design. All subjects were initially identified as average or high-achievers, based on their previous grades in French. The highest grade possible was 6 (excellent) with second best 5 (very good). Only students who had scored 5 and above were included in the high-achievers group. There were 143 high-achieving (87 female and 56 male) and 119 average-achieving (45 female and 74 male) participants. The students of each category were subsequently randomly assigned within each gender to either the visible link or the invisible link condition. There were 72 students (44 females and 28 males) in the high-achievers visible link condition, 71 students (43 females and 28 males) in the high-achievers invisible link condition, 58 students (22 females and 36 males) in the average-achievers visible link condition, and 61 students (23 females and 38 males) in the average-achievers invisible link condition.

4.2. Materials

Text

The text selected for the procedure (see Appendix 1) was a short (181 words) story published in a first year French textbook in the US. It represented a coherent narrative about the career choice of a young Canadian woman. There were 16 words identified by the researcher together with her Bulgarian colleague (French instructor of the subjects) as possibly difficult or unknown for the participants in the study. These 16 words were annotated with Bulgarian translations and were marked in bold face on the computer screen for the visible links group (see Figure 1). These same words, even though annotated, were not marked in any way for the invisible links group.

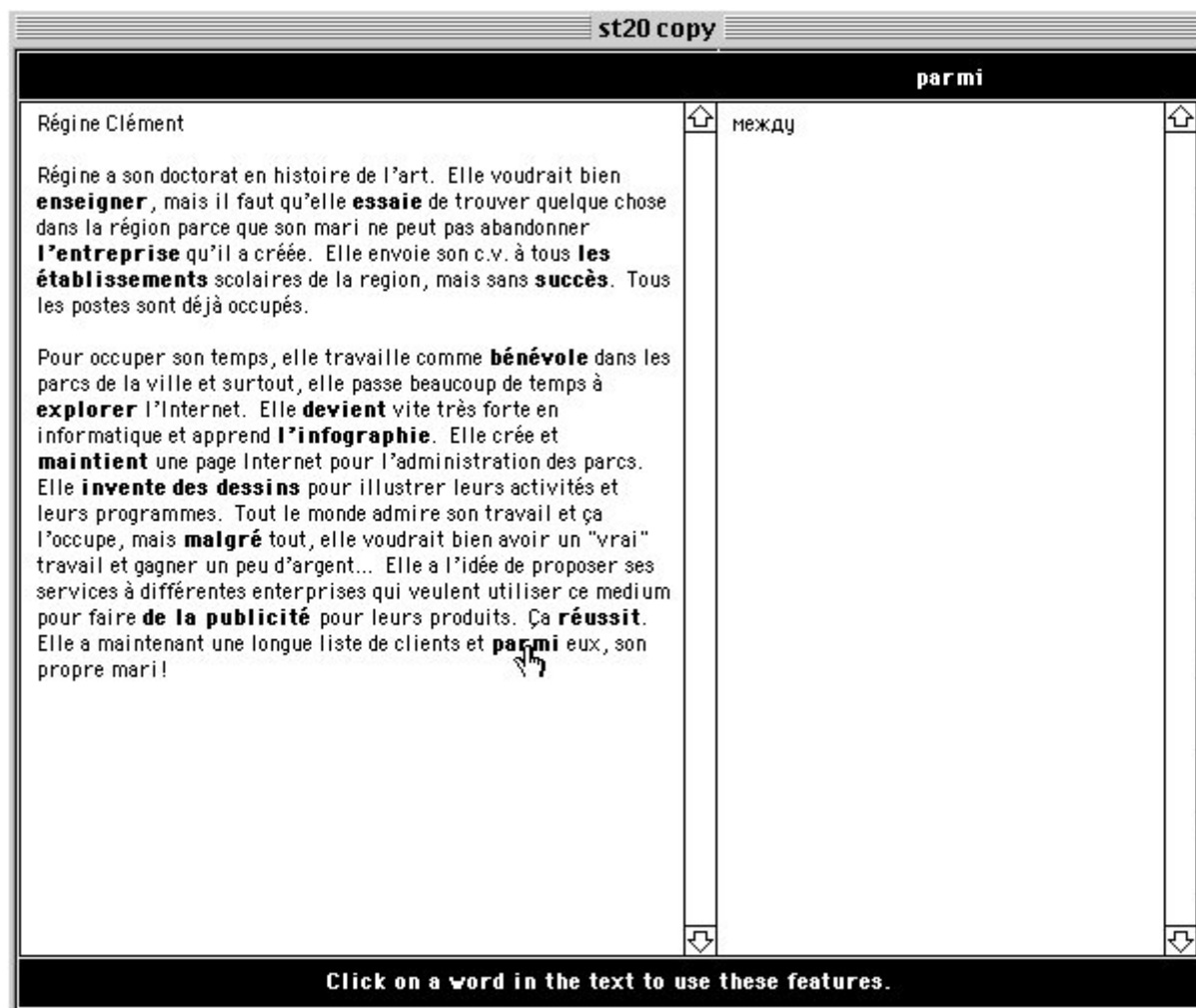


Figure 1

Pretest / Posttest

The pretest (Appendix 2) consisted of the 16 target words and 6 distracters, randomly arranged. The students took the pretest several days before the experiment as part of their regular class work. They were asked to translate all the words from French into Bulgarian. The distracters and the fact that the pretest was administered as part of the subjects' class work were strategies used to limit possible carry-over effects of the pretest. The posttest was the same as the pretest as far as the lexical items were concerned and was administered twice: the first time immediately after the experiment and the second time two weeks after the experiment, in class. Each time the posttest was given, the words in it were rearranged randomly.

The researcher and another teacher of French divided the text into 19 ideas and reading comprehension was tested on the basis of free recall. The students who had recalled correctly all the ideas got the maximum 19 points and for every missing or distorted idea a point was subtracted from the maximum score.

SmarTText Software

SmarTText [SmarTText96] was chosen as the tool for annotating the text. This software package had been used successfully as teaching tool by foreign language faculty prior to the

experiment. The faculty's impression was that the software was user-friendly and students had a positive response to its use.

Demographic survey

A demographic survey (Appendix 4), based on Nikolova (2000) was filled out by all participants during class time prior to the experiment.

4.3. Procedures

Pilot

A pilot test was run with the students from second year French. The procedures were the same as for the experiment. However, the pilot test subjects did not take the delayed posttest. Given the small number of participants in the pilot test (10), it was impossible to seek statistically significant differences in the variables. The most important conclusion from the pilot test was the feasibility of the experiment and the approximate time needed for its administration. Some logistics problems that surfaced at the pilot were corrected for the experiment.

Scheduling, supervision, and pretest

A schedule with 48 time slots of 30 minutes each, spread out over three days was offered to the participants for sign-up. The experiment was held in the language lab where eight computers were reserved during the scheduled time slots. Upon arrival in the lab, each subject was assigned to a computer station according to his / her condition - visible or invisible links.

Treatment

All subjects were instructed to read the text for general comprehension. The visible link group was told that each word in bold face was "hot" - connected to a text annotation (translation in Bulgarian) of the French word. The invisible link group was told that some words were connected with a text annotation (translation in Bulgarian), but the hot words were not marked in any way.

Posttests (immediate and delayed)

After finishing the treatment, the subjects were asked to solve a simple math problem in order to help them empty their short-term memory and direct their attention to a different cognitive task. They were then given the vocabulary and reading comprehension immediate posttest.

Two weeks later, the delayed posttest was administered. It was identical to the immediate posttest with different random arrangement of the words in the vocabulary part. Four subjects from the visible links group and three subjects from the invisible links group did not participate in the delayed posttest for various reasons (dropping the class, illness, etc.).

4.4. Testing the hypotheses

The level of significance at which the hypotheses in the study were tested was $\alpha = .05$. The data, analyzed via the statistical SAS package 8.0 were gathered through the following measurements (see Tables 1, 2, 3, and 4).

| | <u>n</u> | <u>Minimum</u> | <u>Maximum</u> | <u>M</u> | <u>SD</u> |
|----------------------------------|-----------------|-----------------------|-----------------------|-----------------|------------------|
| Pretest | 58 | 0 | 3 | 1.103 | 0.968 |
| Immediate posttest | 58 | 8 | 16 | 12.328 | 1.968 |
| Delayed posttest | 56 | 3 | 8 | 4.875 | 1.237 |
| Reading compreh. im. | 58 | 8 | 16 | 12.586 | 1.816 |
| Reading compreh. del. | 56 | 3 | 9 | 6.554 | 1.205 |

Table 1 - Descriptive statistics for the Average-achievers Visible Links group (AVL).

| | <u>n</u> | <u>Minimum</u> | <u>Maximum</u> | <u>M</u> | <u>SD</u> |
|----------------------------------|-----------------|-----------------------|-----------------------|-----------------|------------------|
| Pretest | 72 | 0 | 3 | 1.667 | 0.919 |
| Immediate posttest | 72 | 8 | 16 | 12.222 | 1.746 |
| Delayed posttest | 70 | 2 | 7 | 4.5 | 1.305 |
| Reading compreh. im. | 72 | 9 | 16 | 12.306 | 1.797 |
| Reading compreh. del. | 70 | 3 | 9 | 6.286 | 1.298 |

Table 2 - Descriptive statistics for the High-achievers Visible Links group (HVL).

| | <u>n</u> | <u>Minimum</u> | <u>Maximum</u> | <u>M</u> | <u>SD</u> |
|----------------------------------|-----------------|-----------------------|-----------------------|-----------------|------------------|
| Pretest | 61 | 0 | 3 | 1.049 | 0.939 |
| Immediate posttest | 61 | 6 | 15 | 10.164 | 1.519 |
| Delayed posttest | 60 | 2 | 6 | 3.633 | 1.073 |
| Reading compreh. im. | 61 | 8 | 16 | 11.672 | 1.850 |
| Reading compreh. del. | 60 | 3 | 10 | 5.733 | 1.528 |

Table 3 - Descriptive statistics for the Average-achievers Invisible Links group (AIL).

| | <u>n</u> | <u>Minimum</u> | <u>Maximum</u> | <u>M</u> | <u>SD</u> |
|----------------------------------|-----------------|-----------------------|-----------------------|-----------------|------------------|
| Pretest | 71 | 0 | 4 | 1.070 | 0.931 |
| Immediate posttest | 71 | 7 | 16 | 12.380 | 1.974 |
| Delayed posttest | 69 | 2 | 7 | 4.623 | 1.318 |
| Reading compreh. im. | 71 | 9 | 16 | 12.282 | 1.614 |
| Reading compreh. del. | 69 | 4 | 10 | 6.130 | 1.123 |

Table 4 - Descriptive statistics for the High-achievers Invisible Links group (HIL).

Hypothesis #1: Immediate Vocabulary Recall

In order to test Hypothesis #1, ANCOVA (ANalysis of COVariance) was performed with dependent variable the mean scores on the immediate vocabulary posttest. The score from the pretest was used as a covariate. ANCOVA compared the means of the scores of the immediate posttest for all four groups adjusted with respect to the pretest scores. The results from the ANCOVA are reported in Table 5. The values of $F(3,261) = 21.97$ and $p < 0.0001$ show that there is a statistically significant difference among the four groups with respect to the dependent variable.

| Source | DF | SS | MS | <u>F</u> | <u>p</u> |
|------------------|-----------|-----------|-----------|-----------------|-----------------|
| Pre | 4 | 52.549 | 13.137 | 4.19 | 0.0026 |
| Group | 3 | 206.496 | 68.832 | 21.97 | <.0001* |
| Pre*Group | 3 | 10.980 | 3.660 | 1.17 | 0.3209 |
| Error | 254 | 793.279 | 3.123 | | |

Table 5 - Analysis of covariance of immediate recall of vocabulary with pretest as covariate. * $p < .05$

In order to identify the group(s) responsible for the difference(s) a post-hoc analysis was performed. A Tukey's studentized range (HSD) test revealed differences in Table 6. The high-achievers invisible links group (HIL) outperformed the average-achievers invisible link group (AIL), the average-achievers visible links group (AVL) outperformed the average-achievers invisible link group (AIL), and the high-achievers visible links group (HVL) outperformed the average-achievers invisible link group (AIL). Comparisons significant at the 0.05 level are indicated by ***.

| GroupComparison | Difference between Means | Simultaneous 95%Confidence Limits | |
|-----------------|--------------------------|-----------------------------------|------------|
| HIL - AVL | 0.0527 | -0.7575 | 0.8629 |
| HIL - HVL | 0.1581 | -0.6075 | 0.9237 |
| HIL - AIL | 2.2163 | 1.4172 | 3.0155*** |
| AVL - HIL | -0.0527 | -0.8629 | 0.7575 |
| AVL - HVL | 0.1054 | -0.7023 | 0.9130 |
| AVL - AIL | 2.1637 | 1.3241 | 3.0032*** |
| HVL - HIL | -0.1581 | -0.9237 | 0.6075 |
| HVL - AVL | -0.1054 | -0.9130 | 0.7023 |
| HVL - AIL | 2.0583 | 1.2617 | 2.8549*** |
| AIL - HIL | -2.2163 | -3.0155 | -1.4172*** |
| AIL - AVL | -2.1637 | -3.0032 | -1.3241*** |
| AIL - HVL | -2.0583 | -2.8549 | -1.2617*** |

Table 6 - Tukey's studentized range (HSD) test.

Hypothesis #1 was, therefore, accepted. The average-achievers invisible links group acquired target language vocabulary significantly worse than the average-achievers visible links group, the high-achievers visible links group, and the high-achievers invisible links groups. There was no significant difference between the performances of both high-achievers groups.

Hypothesis #2: Delayed Vocabulary Recall

In order to test Hypothesis #2, we followed the same route as for testing Hypothesis #1. We performed ANCOVA with dependent variable the mean scores on the delayed vocabulary posttest. The score from the pretest was again used as a covariate. The means of the scores of the delayed posttest for all four groups were thus adjusted with respect to the pretest scores. The results from the ANCOVA are reported in Table 7. The values of $F(3,254) = 16.66$ and $p < 0.0001$ show that there is a statistically significant difference among the four groups with respect to the dependent variable.

| Source | DF | SS | MS | F | p |
|-----------|-----|---------|--------|--------|---------|
| Pre | 1 | 27.966 | 27.966 | 19.43 | <0.0001 |
| Group | 3 | 49.972 | 68.832 | 16.657 | <.0001* |
| Pre*Group | 3 | 2.730 | 0.910 | 0.63 | 0.5965 |
| Error | 247 | 357.065 | 1.446 | | |

Table 7 - Analysis of covariance of delayed recall of vocabulary with pretest as covariate. *p

< .05

In order to identify the group(s) responsible for the difference(s) the same type of post-hoc analysis was performed as for Hypothesis #1. A Tukey's studentized range (HSD) test revealed differences in Table 8. The high-achievers invisible links group (HIL), the average-achievers visible links group (AVL), and the high-achievers visible links group (HVL) all outperformed the average-achievers invisible link group (AIL). Comparisons significant at the 0.05 level are indicated by ***.

| GroupComparison | Difference between Means | Simultaneous 95%Confidence Limits | |
|-----------------|--------------------------|-----------------------------------|------------|
| AVL - HIL | 0.2518 | -0.3063 | 0.8099 |
| AVL - HVL | 0.3750 | -0.1813 | 0.9313 |
| AVL - AIL | 1.2417 | 0.6651 | 1.8182*** |
| HIL - AVL | -0.2518 | -0.8099 | 0.3063 |
| HIL - HVL | 0.1232 | -0.4032 | 0.6496 |
| HIL - AIL | 0.9899 | 0.4421 | 1.5376*** |
| HVL - AVL | -0.3750 | -0.9313 | 0.1813 |
| HVL - HIL | -0.1232 | -0.6496 | 0.4032 |
| HVL - AIL | 0.8667 | 0.3208 | 1.4126*** |
| AIL - AVL | -1.2417 | -1.8182 | -0.6651*** |
| AIL - HIL | -0.9899 | -1.5376 | -0.4421*** |
| AIL - HVL | -0.8667 | -1.4126 | -0.3208*** |

Table 8 - Tukey's studentized range (HSD) test.

Hypothesis #2 was, therefore, accepted. The average-achievers invisible links group retained target language vocabulary significantly worse than all other groups. There was no significant difference between the performances of both high-achievers groups.

Hypothesis #3

In testing Hypothesis #3, we used ANOVA (ANalysis Of VAriance) with dependent variable the mean scores on the immediate reading comprehension posttest. The results from the ANOVA are reported in Table 9. The values of $F(3,261) = 2.87$ and $p < 0.05$ show that there is a statistically significant difference among the four groups with respect to the dependent variable.

| Source | DF | SS | MS | F | p |
|--------|-----|---------|-------|------|---------|
| Group | 3 | 26.875 | 8.958 | 2.87 | 0.0369* |
| Error | 258 | 805.156 | 3.121 | | |

Table 9 - Analysis of variance of immediate reading comprehension. * $p < .05$

In order to identify the group(s) responsible for the difference(s) a post-hoc analysis was performed. A Tukey's studentized range (HSD) test revealed differences in Table 10. The average-achievers visible links group (AVL) outperformed the average-achievers invisible link group (AIL). Comparisons significant at the 0.05 level are indicated by ***.

| GroupComparison | Difference between Means | Simultaneous 95% Confidence Limits | |
|-----------------|--------------------------|------------------------------------|------------|
| AVL -HVL | 0.2807 | -0.5253 | 1.0866 |
| AVL - HIL | 0.3045 | -0.5040 | 1.1130 |
| AVL - AIL | 0.9141 | 0.0763 | 1.7519*** |
| HVL - AVL | -0.2807 | -1.0866 | 0.5253 |
| HVL -HIL | 0.0239 | -0.7402 | 0.7879 |
| HVL - AIL | 0.6334 | -0.1615 | 1.4284 |
| HIL - AVL | -0.3045 | -1.1130 | 0.5040 |
| HIL - HVL | -0.0239 | -0.7879 | 0.7402 |
| HIL - AIL | 0.6096 | -0.1879 | 1.4071 |
| AIL - AVL | -0.9141 | -1.7519 | -0.0763*** |
| AIL - HVL | -0.6334 | -1.4284 | 0.1615 |
| AIL - HIL | -0.6096 | -1.4071 | 0.1879 |

Table 10 - Tukey's studentized range (HSD) test.

Hypothesis #3 was, therefore, accepted. The average-ability invisible links group performed worse than the average-ability visible links group on the reading comprehension measure. There was no statistically significant difference between the performances of the high-achievers visible links group and the high-achievers invisible links groups.

Hypothesis #4

Hypothesis #4 was tested in a way similar to Hypothesis #3. We performed ANOVA with dependent variable the mean scores on the delayed reading comprehension posttest. The results from the ANOVA can be found in Table 11. The values of $F(3,254) = 4.13$ and p

<0.05 show that there is a statistically significant difference among the four groups with respect to the dependent variable.

| Source | DF | SS | MS | F | p |
|--------|-----|---------|-------|------|---------|
| Group | 3 | 20.723 | 6.908 | 4.13 | 0.0070* |
| Error | 251 | 419.684 | 1.672 | | |

Table 11 - Analysis of variance of delayed reading comprehension. * $p < .05$

In order to identify the group(s) responsible for the difference(s) a post-hoc analysis was performed. A Tukey's studentized range (HSD) test revealed differences in Table 12. The average-achievers visible links group (AVL) outperformed the average-achievers invisible link group (AIL). Comparisons significant at the 0.05 level are indicated by ***.

| GroupComparison | Difference between Means | Simultaneous 95%Confidence Limits | |
|-----------------|--------------------------|-----------------------------------|------------|
| AVL - HVL | 0.2679 | -0.3317 | 0.8674 |
| AVL - HIL | 0.4231 | -0.1784 | 1.0247 |
| AVL - AIL | 0.8202 | 0.1988 | 1.4416*** |
| HVL - AVL | -0.2679 | -0.8674 | 0.3317 |
| HVL - HIL | 0.1553 | -0.4121 | 0.7226 |
| HVL - AIL | 0.5524 | -0.0360 | 1.1408 |
| HIL - AVL | -0.4231 | -1.0247 | 0.1784 |
| HIL - HVL | -0.1553 | -0.7226 | 0.4121 |
| HIL - AIL | 0.3971 | -0.1932 | 0.9874 |
| AIL - AVL | -0.8202 | -1.4416 | -0.1988*** |
| AIL - HVL | -0.5524 | -1.1408 | 0.0360 |
| AIL - HIL | -0.3971 | -0.9874 | 0.1932 |

Table 12- Tukey's studentized range (HSD) test.

Hypothesis #4 was, therefore, accepted. The average-achievers invisible links group performed worse than the average-achievers visible links group on the reading comprehension measure. There was no statistically significant difference between the performances of the high-achievers visible links group and the high-achievers invisible links groups.

In conclusion, all hypotheses were accepted, the average-achievers invisible links group was found to perform worse than the average-achievers visible links group on all four independent measures. There were no statistically significant differences between the

performances of high-achievers visible and invisible links groups. Moreover, there were no statistically significant differences between the performances of the average-achievers visible links group and both high-achievers groups on all four independent measures.

5. Discussion

The study found that average-achieving students have significantly higher rates of acquisition of L2 vocabulary (both on the immediate and delayed vocabulary recall posttests) if they use visible hyperlinks than if their hyperlinks are unmarked. The means of immediate vocabulary scores of the average-achievers visible links group and the average-achievers invisible links group in the study were 12.33 and 10.16 words respectively. The means of delayed vocabulary scores were 6.55 and 5.70 words respectively. The results concerning the vocabulary acquisition hypotheses are not surprising. As Mondria and Wit-de Boer found [MondriaWitdeBoer91], more attention toward the link between form and meaning leads to a better retention of the foreign word. Similar findings were reported by Beaton, Gruneberg, & Ellis [BeatonGrunebergEllis95]. Studies based on the noticing hypothesis ([Fotos93] ; [Robinson95] ; [Schmidt90]) also emphasized the beneficial effects of increased attention toward and conscious awareness of the link between form and meaning. Increased attention in the present study was attained through a visible link to the target word, which made the target vocabulary item more salient. The effect of salience of vocabulary items was noticed previously by Brett ([Brett97] ; [Brett98]) in studies on listening comprehension. In our case, the subjects in the visible links groups received an overt external pointer to the form of the word they were trying to understand, which prompted them in turn to seek its meaning by clicking on the highlighted word. The salience of the vocabulary item thus ensured its better acquisition as measured by immediate as well as delayed posttests.

Our results also brought evidence that neither the immediate nor the delayed vocabulary recall of the high-achieving students was in any way significantly different in the marked condition compared to the unmarked one. High-achieving students have similar rates of acquisition of L2 vocabulary (both on the immediate and delayed vocabulary recall posttests) whether they use visible hyperlinks or the hyperlinks are unmarked. The means of immediate vocabulary score of the high-achieving visible links group and the high-achieving invisible links group in the study were 12.22 and 12.38 words respectively. The means of delayed vocabulary score were 4.5 and 4.62 words respectively. Why did the salience of the marked vocabulary item not contribute to an improved vocabulary score for high-achieving students? A likely explanation of this occurrence is that high-achieving students possess metacognitive skills, which make external pointers irrelevant. One could argue that in the unmarked condition, they perform at the peak of their abilities and thus, the marking of the hyperlinks cannot possibly improve their performance.

It should also be noted that, while there was a significant difference between the performance of the average-achievers invisible links group and the average-achievers visible links group, there was no such difference between the performance of the average-achievers visible links group, the high-achievers visible links group and the high-achievers invisible links group. It may be argued, therefore, that visibility of hyperlinks acts like an additional “tool” which affects only part of the student population – namely average-achieving students, bringing up their performance to the level of high-achieving students.

On the surface this study's results contradict the conclusions drawn by DeRidder [DeRidder02]. Recall that she did not find significant differences between the performances of her visible links and invisible links groups. However, our study took the analysis of comparisons between visible and invisible links groups a step further introducing the factor of learner characteristics. It is quite possible that the differences that we could identify when considering two different student populations, were lost when the performance of the general student population was analyzed.

As far as reading comprehension is concerned, our findings were somewhat less conclusive. There was still a significant difference between the immediate and delayed reading comprehension scores of the average-achievers visible links group and the average-achievers invisible links group: 12.59 and 6.55 and 11.67 and 5.70, respectively, but the numerical difference was a lot smaller than with the vocabulary task. In addition, the scores of both average-achievers groups were sufficiently close as not to yield any difference between the high-achievers groups on the one hand, and any of the average-achievers groups, on the other hand. One possible explanation of these results may be that finding the meaning of the word after looking it up in the reading process had a more direct impact on the vocabulary acquisition parameter, but its impact on the reading comprehension measure was somewhat indirect. This is not surprising in light of theories which posit a less direct link between vocabulary knowledge and reading comprehension [ChunPlass97]. Since the differences, even though clearly statistically significant for the vocabulary acquisition, were not very substantial when expressed in numbers, their indirect impact may have been somewhat lost on the reading comprehension measure.

Overall, this study's findings are in line with Garfinkel & Prentice's [GarfinkelPrentice85] ideas about the importance of external pointers and more structure for average-ability students who lack high levels of metacognitive awareness and need more overt guidance during the learning process. Not only did the salience of the marked glosses not distract the learners ([DeRidder02] ; [DeRidderVanWaes00]), moreover, as we had hypothesized, it actually led to an increased vocabulary acquisition and reading comprehension for the average-achieving students. It did not alter in any way the vocabulary acquisition or reading comprehension of high-achieving students who most likely did not need external pointers. After all, as Winner [Winner97] remarks, one of the most important characteristics of gifted and talented students is their independence in terms of organization of their work, and control over the tasks that need to be carried out. If, however, a simple external pointer to a task is capable to neutralize the difference between high- and average-achievers in any kind of academic endeavor, it is, in our understanding, worth the effort.

6. Conclusions, limitations and recommendations

The present study made an attempt to investigate, for the first time, some quantitative parameters of vocabulary learning and reading comprehension for students with different achievement patterns using visible and invisible links in a hypertext environment for foreign language learning. The novel character of this research makes it impossible to generalize the findings of the study beyond the conditions described in this article, without replication of the experiment.

The main question of the study - whether visible hyperlinks have a positive impact on

students and which student population they benefit - was answered in an unequivocal way. Average-achievers benefit from marked links and their performance improves to reach the levels of performance typical for high-achieving students. In general, the results of the study should be interpreted cautiously because of the small numerical difference in the scores of the different groups, particularly on the measures of reading comprehension, and the relatively short treatment. A future study might be devised whereby students should be asked to work on longer texts in several sessions over a longer period of time. The students may also be given attitude questionnaires, which could monitor their overall impressions from the treatment in order to help study the impact of visible hyperlinks more in-depth. This goal may be also attained by think-aloud protocols, which can reveal the exact path of the students' thinking processes.

Reading comprehension may be explored by including different tasks – one general and one specific in order to compare students' performance under different conditions and more precisely whether, as DeRidder [DeRidder02] contends, general tasks are likely to increase vocabulary acquisition and whether different ability students would perform differently on these different tasks.

In conclusion, the study confirmed DeRidder's [DeRidder02] findings that visible links do not act as distractors for any of the groups represented in this study. Since, in addition, their impact on the average-achievers group was positive, our recommendation for people creating software would be to use marked links for annotated words. It is our hope that the findings in this study can help designers of educational software make decisions about the format of links for word annotating.

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Appendices

Appendix 1. Text

Régine Clément

Régine a son doctorat en histoire de l'art. Elle voudrait bien enseigner, mais il faut qu'elle essaie de trouver quelque chose dans la région parce que son mari ne peut pas abandonner l'entreprise qu'il a créée. Elle envoie son c.v. à tous les établissements scolaires de la région, mais sans succès. Tous les postes sont déjà occupés.

Pour occuper son temps, elle travaille comme bénévole dans les parcs de la ville et surtout, elle passe beaucoup de temps à explorer l'Internet. Elle devient vite très forte en informatique et apprend l'infographie. Elle crée et maintient une page Internet pour l'administration des parcs. Elle invente des dessins pour illustrer leurs activités et leurs programmes. Tout le monde admire son travail et ça l'occupe, mais malgré tout, elle voudrait bien avoir un "vrai" travail et gagner un peu d'argent... Elle a l'idée de proposer ses services à différentes entreprises qui veulent utiliser ce medium pour faire de la publicité pour leurs produits. Ça réussit. Elle a maintenant une longue liste de clients et parmi eux, son propre mari!

Appendix 2. Words for the pretest and posttest

dessins

l'infographie

demain

réussit

bénévole

invente

récite

essaie

entreprise

parmi

explique

maintient

publicité

établissements

succès

entre-temps

explorer

partie

enseigner

invite

devient

malgré

Appendix 3. Text and ideas

Régine a son doctorat en histoire de l'art (1). Elle voudrait bien enseigner (3), mais il faut qu'elle essaie de trouver quelque chose dans la région (4) parce que son mari ne peut pas abandonner l'entreprise qu'il a créée (5). Elle envoie son c.v. à tous les établissements scolaires de la région (6), mais sans succès (7). Tous les postes sont déjà occupés (8).

Pour occuper son temps, elle travaille comme bénévole dans les parcs de la ville (9) et surtout, elle passe beaucoup de temps à explorer l'Internet (10). Elle devient vite très forte en informatique et apprend l'infographie (11). Elle crée et maintient une page Internet pour l'administration des parcs (12). Elle invente des dessins pour illustrer leurs activités et leurs programmes (13). Tout le monde admire son travail et ça l'occupe (14), mais malgré tout, elle voudrait bien avoir un "vrai" travail et gagner un peu d'argent (15)... Elle a l'idée de proposer ses services à différentes entreprises qui veulent utiliser ce medium pour faire de la publicité pour leurs produits (16). Ça réussit (17). Elle a maintenant une longue liste de clients (18) et parmi eux, son propre mari (19)!

Appendix 4. Demographic survey

Prière d'écrire vos réponses dans les espaces ci-dessous :

Question #1

Votre sexe. Encerclez M F

Question #2:

Combien de semestres avez-vous suivi des cours de français? Dans votre réponse comptez chaque année de lycée comme deux semestres. Ne comptez pas le semestre actuel.

REPONSE: _____

Question #3:

Quelle était votre note dans votre dernier cours de français?

A = 4, B = 3, C = 2, D = 1, F = 0.

REPONSE: _____

Question #4:

En quelle année de vos études êtes-vous à présent?

Première deuxième troisième quatrième maîtrise / doctorat

Question #5:

Sur une échelle de 1 à 10, où 1 = mauvais et 10 = excellent donnez une évaluation de votre maîtrise de l'ordinateur. Encerclez le nombre correspondant:

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Question #7:

Sur une échelle de 1 à 10, où 1 = mauvais et 10 = excellent indiquez votre attitude envers l'enseignement via ordinateur. Encerclez le nombre correspondant:

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Question #8:

Sur une échelle de 1 à 10, où 1 = mauvais et 10 = excellent indiquez votre attitude envers le français en tant que matière enseignée. Encerclez le nombre correspondant:

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Question #9:

Pourquoi suivez-vous un cours de français? Encerclez une ou plusieurs réponses. Si vous choisissez "autre" , expliquez brièvement:

- 1) obligatoire pour mon programme d'études
- 2) le cours n'est pas obligatoire pour mon programme, mais j'aime le français
- 3) autre

Note

[*] Note from the editorial board: The French version of the same article written by O. R. Nikolova is published in this issue.

About the author

Ofelia R. NIKOLOVA is currently Assistant Professor of French in the Department of Foreign Languages and Literatures at Southern Illinois University at Carbondale. Her research interests are in second language acquisition, CALL and multimedia in foreign language learning, foreign language education for the gifted. She has published articles and presented papers in these areas.

Email: ofeliarn@siu.edu

Address: Department of Foreign Languages and Literatures, Southern Illinois University at Carbondale, USA.

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