

## Hypereference and Conventional Dictionary Use While Reading a Foreign Language

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### **Abstract**

*A hypereference is defined as an electronic aid which provides immediate access to adjunct information with a clear and direct return path to the target information. Eighty undergraduate foreign language learners participated in this investigation of hypereference and conventional paper-based dictionary media on consultation frequency, reading time and comprehension. Findings revealed that the hypereference users consulted over two times as many definitions as those who used paper dictionaries. Although they consulted more definitions, the hypereferences users did not have higher overall reading times indicating the efficiency advantages of hypereferences. Differences on comprehension were not significant.*

*A second aspect of this study compared bilingual and monolingual dictionary use across media on consultation frequency and reading time. Bilingual dictionary users consulted over 25% more definitions and completed reading in 20% less time than those who used monolingual dictionaries. Suggestions for additional research and development with hypereferences are offered.*

Since the beginning of personal computing a little over a decade ago, word processing has exemplified the benefits that electronic data management offers over established methods of writing with a pencil or typewriter. These advantages are particularly evident to those language educators who have found that word processing makes it easier to rearrange text during revisions (Leonardi, 1987), enhances the quality of printed copy which results in greater pride of authorship (Kahn, 1987; Baer, 1988), and improves access to reference tools such as a spelling checker or thesaurus (Kasnic & Stefano, 1987). But despite the evident success of word processing, visions of paperless schools and offices appear even more distant now than in

the early days of personal computing. This is because the majority of information that currently begins in electronic format is converted to before it is read. The study reported here considers potential benefits of learning directly from electronic-based information which is viewed as a viable alternative to the growing managerial and ecological pitfalls of an ever increasing dependence on paper.

### **Hypertext and Hypereferences**

The general term hypertext has recently been used to describe an array of emerging technologies for accessing, organizing and relating electronic-based information. Ted Nelson (1981, 1982) is credited with the first use of this term in reference to a hypothetical electronic notebook which allows users to immediately consult elaborations on any word or phrase by simply pointing to or "clicking" the information that they may wish to learn more about. Nelson's ideas for this hypertext notebook can be traced to Vannevar Bush (1945) who described a mechanism called the *Memex* as "a device in which an individual stores his books, records, communications, and which is mechanized so that it can be consulted with exceeding speed and flexibility." (106-7). Bush believed that the *Memex's* immediate and flexible access to information was similar to the way humans think. Consequently, he claimed that the *Memex* would be of greater benefit to human communication and learning than existing information management tools.

Until recently, prototypes based on the *Memex* were accessible only to investigators, such as Engelbart and English (1968), experimenting in isolated labs connected to powerful mainframe computers and mass storage devices. However, advances in the storage capacity and processing speed of personal computers combined with software,

such as HyperCard and pen-based operating systems, are making the features of hypertext accessible to a much broader range of learners.

Many strategies for applying hypertext to instruction have been formulated (Campbell & Goodman, 1987; Halasz, 1987; Smith & Weiss, 1988). Some of the more recent designs are called hypermedia (Kinzie & Berdel, 1990). Hypermedia are enhanced hypertext implementations which capitalize on the mass storage capacity of videodiscs and CD-ROM to expand the range of presentation media. Using a hypermedia resource, a learner might click the word "whistle" and have the option of hearing either the standard pronunciation or one of several whistle sounds. In another use of hypermedia, clicking the word "throw" would present options to view full-motion video clips depicting a variety of throwing techniques.

Early commercial adaptations of hypertext/hypermedia will likely be based on existing comprehensive modular references such as textbooks, encyclopedias and dictionaries (Locatis, Letourneau, & Banvard, 1989). A recent survey by Wooldridge (1991) found that 58 dictionaries are now available in electronic format and systems are being proposed for automatically adapting such references to hypertext environments (Raymond & Tompa, 1988). In a full-fledged hypertext environment, users would have unlimited freedom in accessing a range of knowledge bases that are interconnected to form multidimensional webs of information providing multimedia elaborations on any picture, word or phrase.

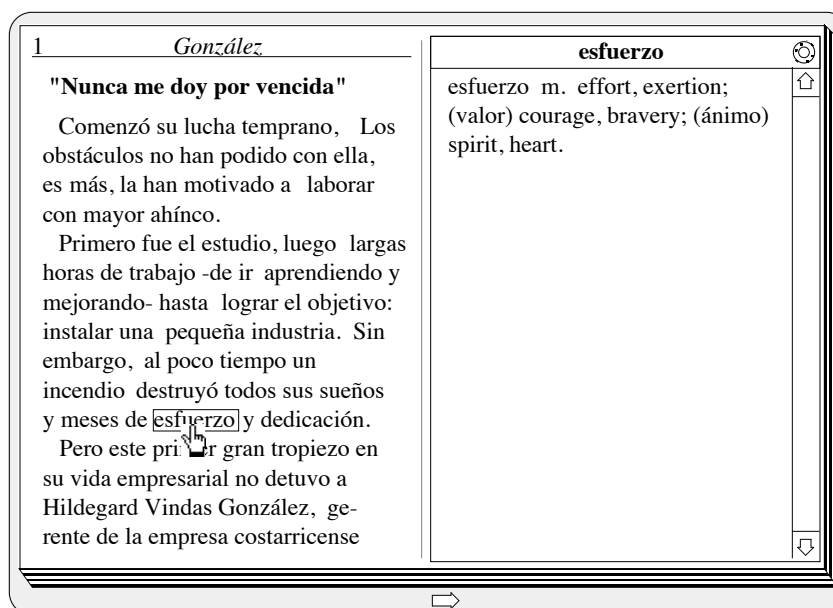
As indicated by the increase in electronic dictionaries, the proportion of information being produced in electronic format is rising exponentially. With anticipated improvements in screen resolution, learners may elect to consume a much larger percentage of information directly from computer screens. Hypertext has been touted as a revolutionary means of presenting information, but empirical research focusing on how and if people will use hypertext systems is surprisingly sparse. Furthermore, there is concern that poorly implemented hypertext systems could be detrimental in many learning situations. Full-fledged hypertext systems may accommodate the non-linear styles of some learners while other learners may be confronted with what Kerr (1986) describes as the "wayfinding" problems

that are encountered when users get lost in the hypertext webs.

The current study represents a beginning step in investigating the potential of hypertext for improving the use and effectiveness of references while reading. The hypertext approach is based on a direct bi-directional electronic dictionary. That is, when a user clicks a word in an electronic text, the definition appears immediately. Once the definition appears, the only option is to return directly to the text - words within the definitions cannot be consulted (see Figure 1). We describe this electronic dictionary as a simple hyperreference implementation. A hyperreference is defined as any form of electronic aid that offers immediate access to supportive information with a clear and direct return path to the target information. Although hyperreferences may not offer the unrestricted mobility envisioned by Bush and Nelson, they do limit possible wayfinding problems and may be especially useful when the instructional tasks center on understanding specific chunks of information. The use of a simple hyperreference in this study also focuses the investigation on the direct and immediate access features of hypertext. The impact of these features would be more difficult to isolate if a completely open hypertext system were used.

The ability to immediately consult a hyperreference and then directly return to the target information has distinct implications for instruction. Locating information in conventional references often involves a few minutes walking across the room and searching through indexes. A similar search in a hyperreference could take place in a matter of seconds or less. Learners who would otherwise forego many consultations, because of the time and effort involved in searching through conventional references, may use a hyperreference much more frequently. The additional time taken to locate a particular topic within conventional references can also hinder comprehension because the learner is distracted from the target information to a greater extent than in a brief hyperreference excursion. Thus, hyperreferences may improve the efficiency of consuming information because a greater number of consultations take place in less time without disturbing the learner's focus on the target information.

Figure 1: Electronic Book with Hyperreference



*In the above depiction of the electronic book, the user has clicked the word "esfuerzo" and the definition appeared in the window on the right page. The button in the upper right corner is used to close the definition window. This figure shows the bilingual (English) version. A second version that provided monolingual (simplified Spanish) definitions was also used in the study.*

### Foreign Language Dictionaries

Foreign language was selected as the content discipline for investigating the use of references because learning a foreign language typically involves considerable dictionary usage, thereby creating a rich "lookup" environment. Another reason for selecting this content was the evident need for additional research concerning the use of dictionaries while studying a foreign language. Educators often have strong opinions about the proper and improper use of dictionaries, however, there is little empirical evidence to support assertions concerning when and how language learners make effective use of dictionaries (Hartmann, 1987; Ilson, 1985; Lantolf, Labarca, & den Tuinder, 1985). Lexicographers have pointed to the need for psycholinguistic research to address this issue (Zgusta, 1975; Crystal, 1986). In the words of one scholar, "it is time to replace impressionistic

opinions and speculations by factual evidence based on empirical research" (Hartmann, 1983, p. 199).

Studies based on self-report questionnaires have offered some insights to how dictionaries are used (Tomaszczyk, 1979; Béjoint, 1981; Galisson, 1983; Coviello, 1987). Although these surveys report learners' claims regarding their use of dictionaries, investigators (Hatherall, 1984; Hartmann, 1987) have called for research which monitors dictionary use more directly. Computer-based monitoring systems provide unobtrusive means for collecting data on reference usage patterns. Computers also afford consistent and reliable methods for data collection that have been well-established in cognitive psychology (Gagné, 1985).

As is true of their paper-based forbears, there are many unresolved design issues pertaining to the effective use of hyperreferences. Scholars (Keller, 1987; Strevens, 1987) have speculated

that computer dictionaries may promote better dictionary usage by language learners. However, these suppositions have not been substantiated. Many learners may find the open and immediate access to a vast amount of information overwhelming and respond with repetitive trips along familiar paths. Applying this notion to a hypereferences which would allow users to consult definitions in either their native or target languages, learners may consistently prefer information in their native language.

Dictionaries designed to support foreign language learning fall into two central categories: bilingual dictionaries, which provide the reference word in the target language and definitions in the readers' native language, and monolingual dictionaries that include both the reference word and simplified definitions in the target language. Research has found that foreign language learners have a distinct preference for bilingual dictionaries (Benoussan, Sim & Weiss, 1984; Atkins, 1985). Nonetheless, many language educators (Yorkey, 1970; Snell-Hornby, 1984) believe that bilingual dictionaries are counterproductive because they cultivate the naive assumption that there is a one-to-one correspondence between the words of the two languages. By avoiding definitions in the target language, the learner may simply be translating and thereby missing potentially valuable learning activities involving reading and thinking in the target language.

### *Assumptions*

One dimension of this study compares conventional and hypereference dictionaries on frequency of use, overall reading time and comprehension. Because hypereference dictionaries offer immediate access to supportive information, we expected that the definitions would be consulted more frequently and that the combined reading and consultation time would be less when consulting a hypereference than when consulting a conventional dictionary. The ease of accessing a hypereference and returning to the target text should also benefit the learner's ability to focus on the passage being read. Consequently, comprehension may be greater when reading and consulting a hypereference than when reading the same passage while consulting a conventional dictionary.

Bilingual and monolingual dictionaries were also compared across both the hypereference and conventional paper-based conditions. Dependent measures were frequency of use and overall reading time. The preference for bilingual dictionaries, as reported in previous studies, was expected to prevail with the bilingual dictionary being consulted more frequently than the monolingual. Definitions in bilingual dictionaries tend to be briefer and require less effort to process than definitions in monolingual dictionaries. Consequently, we expected that the combined reading and consultation time would be less when consulting a bilingual dictionary than when consulting a monolingual dictionary.

### **Method**

A comparison of hypereference and conventional paper-based presentation media as well as the dictionary language dimensions of bilingual (English-Spanish) and monolingual (simplified Spanish) were compared using a 2 X 2 (presentation media X definition language) design. Presentation media was compared on three dependent measures: frequency of consultations, reading time and comprehension. Definition language was compared on two dependent measures: frequency of consultations and reading time.

### *Subjects:*

Of the 80 undergraduates who volunteered to participate in the study, 27 were male and 53 were female. At the time of the study, all subjects were enrolled in sections of a fifth-semester university Spanish course. They reported an average of 3.3 years of Spanish coursework prior to attending university. The mean number of university semester hours completed was 67 with a mean GPA of 3.16 for all university coursework. Subjects also reported that they had completed an average of 11 hours of university Spanish coursework with a mean GPA of 3.44.

### Materials

The text used in all conditions was a replica of the 420 word article entitled Nunca me doy por vencida which appeared in the November 21, 1989 issue of the Costa Rican magazine Rumbo. The Rumbo article was chosen because it was judged by a professor of Spanish to be moderately difficult for students in their fifth-semester of Spanish. Results from a cloze version of the article, which was completed by 16 fifth-semester students prior to conducting the study, supported the professor's judgement. The mean restoration rate on this cloze was 42.3%, which approached the 44 to 53% range that is used as a practical guide in determining whether a passage is above frustration level while being challenging enough for instructional use (Haskell, 1975). The Rumbo article was also chosen to control for individual differences in background knowledge. The biographical sketch schema is the kind of narrative that is likely to be universally understood by subjects of this age, educational level, and cultural background.

Replicas of the article were prepared for four conditions: A) electronic article/bilingual hyperreference dictionary, B) electronic article/monolingual hyperreference dictionary, C) paper-based article/bilingual conventional dictionary and, D) paper-based article/monolingual conventional dictionary.

A prototypic electronic paperback was developed for the two hyperreference conditions (A and B) using HyperCard software. The Rumbo article was transcribed to five pages of the electronic paperback. Each computer screen includes two pages. Navigation through the electronic paperback is accomplished by clicking small forward and back buttons appearing at the bottom of each page. Definitions can be consulted for any word in the electronic paperback, and after a word is clicked, the definition window immediately appears on the page opposite from the selected word. This opposing-page feature is designed so that the word and its context remain visible while the definition is being read. When the definition window is closed, the underlying text reappears. Definitions for words in condition A were transcribed from the bilingual dictionary used in condition C. Definitions for condition

B were from the monolingual dictionary used in condition D. The computer tutorial, which preceded the electronic paperback, provided practice in the use of the mouse, navigating through pages in the Rumbo article, consulting the hyperreference dictionary and guidelines for the study.

Parallel forms of the electronic paperback were produced for the conventional dictionary conditions (C and D). A 6 by 8.5 inch paper copy of the electronic paperback was produced from direct screen files to assure for format and size consistency across all conditions. Subjects in condition C received this paper version of the Rumbo article and a copy of the bilingual dictionary American Heritage Larousse Spanish Dictionary. Subjects in condition D received the paper article and the Diccionario Larousse del español moderno monolingual dictionary. Instructions for underlining the words that were consulted in the dictionaries and guidelines for the study preceded the pages on which the article appeared.

### Measures

The consultation measure was the raw number of words that the subjects looked up in the dictionary. In the computer conditions, each word that was clicked on was automatically recorded as a consultation. For the paper-based conditions, subjects underlined the words they looked up in the conventional dictionary directly on the passage.

Reading time was the number of seconds that transpired between the time when the subjects had completed the orienting phase and indicated they were ready to begin reading, and the time when they reported that they had completed reading and were ready for testing. Thus, reading time included both the time involved in reading the text and the time taken to consult the dictionary.

Comprehension was a measure of the number of propositions found in the written recalls of the Rumbo article (Bernhardt, 1983; Lee, 1986). The article was reviewed prior to data collection using the identification scheme refined by Deese (1984) with the evaluators agreeing that the text contained 65 propositions.

Blind reviews of the 80 written recalls were independently conducted by two evaluators. A correlation coefficient of .96 between the two evaluators' ratings indicated a high degree of inter-rater reliability (Moore, 1983). The comprehension score assigned to each written recall was the mean proposition rating of the two evaluators.

### *Procedures*

At the beginning of the spring semester classes, subjects were informed that they would receive a nominal addition to the points used in determining course grades for participating in the study. The 80 subjects who volunteered were randomly assigned to one of the four treatment conditions - 20 per group.

Each condition was preceded by an orientation phase lasting about 10 minutes. Subjects who received the electronic text conditions completed the computer tutorial that oriented them to the study and explained how to use the hypereference. Orientating instructions and an example for the underlining procedure were also given at the beginning of the paper-based conditions.

During the orientation for each condition, the subjects read the following statement, "You will have up to 30 minutes to read the six page Spanish passage so you will have plenty of time to look up as many word as you wish. After reading the Spanish passage, you will be asked to write everything you can remember about the story. Your score will be based entirely on the contents of your description and will not be influenced by the number of words you looked up or by the amount of time you took to read the story." At the conclusion of the orientation phase, the observer consulted with each subject to assure that procedures were thoroughly understood. After responding to any questions, the observer advised the subject to begin reading and recorded the start time.

When they had completed reading the story, subjects notified the observer that they were ready to write the description. The end of the reading time was then recorded and the observer gave the subject a response sheet. Instructions on the response sheet explained that subjects were to write down everything they could remember about the story.

Observers conducted an open and informal interview with several subjects after they had handed in their written recalls. The questions asked were designed to provide general insights into the subjects' opinions about the usefulness of the dictionaries and the difficulty level of the passage.

## **Results**

### *Reference Media Data*

A 2 X 2 (presentation media X definition language) analysis of variance on frequency of consultations revealed that the group who used the hypereference consulted over two times as many definitions ( $\bar{M}$ =28.3) as those who used conventional dictionaries ( $\bar{M}$ =13.1),  $F(1,76)=26.96$ ,  $p<.001$ .

Under the pre-imposed .05 probability level, there was no significant difference between the hypereference and conventional dictionary groups on combined reading and consultation time. As will be explained further in the discussions, researchers may wish to note that although the mean number of consultations was over twice as high for the two groups who used hypereference dictionaries, the mean reading time recorded for the groups that used the hypereference dictionaries ( $\bar{M}$ =1129.6s) was nearly 20% less than the mean time taken by those who used conventional dictionaries ( $\bar{M}$ =1400.3s),  $F(1,76)=3.76$ ,  $p=.056$ .

The mean number of propositions recalled (comprehension) by the groups who used the hypereference dictionaries ( $\bar{M}$ =11.0) was not significantly different from those who used conventional dictionaries ( $\bar{M}$ =12.7)  $F(1,76)=1.21$ .

A post hoc analysis revealed a significant positive correlation,  $r=.44$ ,  $p<.01$ , between the comprehension and overall GPA as well as between comprehension and GPA in university Spanish courses  $r=.35$ ,  $p<.01$ . These correlations help to confirm the appropriateness of using the proposition recall as a measure of comprehension. However, further post hoc analysis did not find significant differences between the reference media when either overall GPA or GPA in Spanish courses was used as a covariate.

Table 1: ANOVA on Consultations by Dictionary Media and Definition Type

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	5286.65	2	2643.33	15.52	.000
Dictionary Media	4590.45	1	4590.45	26.96	.000**
Definition Type	696.20	1	696.20	4.09	.047*
2-Way Interactions	320.00	1	320.00	1.88	.174
Explained	5606.65	3	1868.88	10.98	.000
Residual	12940.90	76	170.28		
Total (n=80)	18547.55	79	234.78		

\* $p < .05$     \*\* $p < .001$

Table 2: Mean Number of Consultations by Dictionary Media and Definition Type

Dictionary Media	Definition Type	Mean	SD	N
Conventional		13.10	5.95	40
	Bilingual .....	14.05	6.68	20
	Monolingual.....	12.15	5.11	20
Hypereference		28.25	17.96	40
	Bilingual .....	33.20	19.82	20
	Monolingual.....	23.30	14.75	20

Note: Overall Bilingual  $\bar{M}$  = 23.63; overall Monolingual  $\bar{M}$  = 17.73.

Table 3: ANOVA on Reading Time by Dictionary Media and Definition Language

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	3207323	2	1603661.71	4.11	.020
Dictionary Media	1464758	1	1464757.81	3.76	.056
Definition Type	1742566	1	1742565.61	4.47	.038*
2-Way Interactions	366257	1	366257.11	.940	.335
Explained	3573581	3	1191193.51	3.056	.033
Residual	29624414	76	389794.92		
Total(n = 80)	33197995	79	420227.78		

\* $p < .05$

Table 4: Mean Reading Time by Dictionary Media and Definition Type

Dictionary Media	Definition Type	Mean	SD	N
Conventional		1400.3s (23:20) <sup>a</sup>	757.9	40
	Bilingual .....	1185.0s (19:45)	567.0	20
	Monolingual.....	1615.5s (26:56)	871.1	20
Computer		1129.6s (18:50)	489.2	40
	Bilingual .....	1049.7s (17:30)	372.7	20
	Monolingual.....	1209.6s (20:10)	582.0	20

Note: Overall Bilingual  $\bar{M}$  = 1117.4s; overall Monolingual  $\bar{M}$  = 1412.5s.

<sup>a</sup> Reading time units for analysis were seconds. Minutes and seconds appear in parentheses.

### *Dictionary Language Data*

The group who used the bilingual dictionaries (both hypereference and conventional) made over 25% more consultations ( $M=23.6$ ) than those who had access to the monolingual version ( $M=17.7$ ),  $F(1,76)=4.09$ ,  $p>.05$ . Subjects who had access to the bilingual versions also spent about 20% less time reading and consulting the dictionary ( $M=1117.4s$ ) than those who had access to the monolingual versions ( $M=1412.5s$ ),  $F(1,76)=4.47$ ,  $p>.05$ .

Informal interviews that were conducted after the written recalls were turned in suggested that the subjects believed the difficulty level of the passage was appropriate. Several subjects in the hypereference conditions indicated that they were comfortable using the computer by explaining that they either had a computer at home or that they used a computer regularly in support of school assignments. When these subjects were asked what they thought of the hypereference dictionary, responses were generally enthusiastic. For example, one subject responded, "It's great! It makes looking up words a lot easier. Where can I get one?"

The most common concern raised during the interviews came from those who received monolingual dictionaries. For example, one subject under the monolingual conventional dictionary condition explained "It was not like the dictionary I'm used to. It wasn't much help." When asked what type dictionary she used, she pulled a worn copy of the same dictionary used in the bilingual conditions from her purse. One of the subjects in the monolingual/hypereference condition also commented that he wished he could have clicked on the words in the definitions for further explanation. In essence, he was asking for a more fully implemented hypereference.

## **Discussion and Recommendations**

### *The Use of Hypereferences*

Results of this study indicate that hypereferences are consulted more frequently than comparable conventional references. By facilitating consultations, hypereferences make it easier for learners to become actively involved in consuming information, which is consistent with

current constructivist views of learning. Given the scope of the present research, our findings alone do not warrant far-reaching conclusions concerning the influence of hypereferences on the learners' general level of curiosity or inquiry skills.

Hypereferences offer easier and more efficient access to adjunct aids resulting in more consultations in a given amount of time. When a consultation efficiency rating was calculated (number of consultations/reading time in seconds), hypereferences ( $M=.025$  or 1.5 consultations per minute) proved considerably more efficient than conventional dictionaries ( $M=0.10$  or 6 consultations per minute),  $F(1,76)=90.1$ ,  $p>.001$ . Because this effect may be partially or entirely attributed to differences in consultation frequency, a comparison of dictionary media on reading time was considered independently from consultation frequency. Another reason for analyzing reading time independently from the number of consultations was to address questions regarding possible detrimental effect from excessive use of hypereferences. That is, the ease of use and/or novelty of a hypereference may lower the consultation trigger point, resulting in unnecessary distraction from the target information because learners spend too much time looking up adjunct information that they are relatively familiar with.

Findings did not suggest that hypereferences increase the combined reading and consultation time. Instead, the use of hypereferences in rich "lookup" environments, such as foreign language study, may reduce the overall reading time. When hypereference and conventional dictionaries use was compared on reading time the pre-imposed .05 probability level was narrowly missed ( $p=.56$ ). Furthermore, the effect was in the predicted direction with the mean reading time for the hypereference group about 20% less than for those who used conventional dictionaries. Researchers, who conduct further studies with hypereferences may wish to increase sensitivity to differences in reading time by incorporating text materials that are somewhat longer than the 420 word article used in this study.

This study did not find that reference media influenced comprehension. However, conditions were limited by the use of a single five-page foreign language passage and more global effects



on comprehension may result when hypereferences are used over extended periods. Additional research is needed to investigate the use of hypereferences with a variety of reading materials over longer time periods. These studies might also consider the influence of hypereferences on such outcomes as vocabulary acquisition and general inquiry skills development.

The hypereference used in this study could be expanded on several dimensions for further research and development. For example, hypertext capabilities could be extended to allow users to consult words within definitions. Media support could be augmented to include word pronunciation or iconic representations. Annotational capabilities might include the glosses supplied by editors or possibly the more personalized "metanotes" (Wolfe, 1990, p. 223) that are similar to the handwritten note which readers write for themselves in margins. Alan Kay (1991), a noted developer of simulations software, anticipates that during the next ten years educational software will begin to incorporate "flexible agents" which tailor learning environments to each learner and situation. Such agents could be used in constructing personalized adjunct aids according to the context of the target information as well as the preference and learning style of the user.

If these visionary hypereferences are implemented, what will be the trade off between open access and chaos? When does media augmentation promote learning and when is it distracting? How much processing should be driven by machine and how much should be left to the learner? Jonassen (1991) is in favor of incorporating notions of diversity and open access, inherent in hypertext/hypermedia environments, within existing instructional design strategies to develop models that are more compatible with cognitive views of learners. Clearly, much discussion and research will be needed before such models can be recommended with conviction. For example, the use of a hypereference augmented with sound may improve performance on certain pronunciation measures but raise controversy regarding the homogenization of dialects. The bells, whistles and freedom of choice in a full-fledged hypermedia environment may interfere with instruction focusing on the near-term understanding of specific information

but prove effective in promoting general inquiry abilities. As Jonassen and others (Locatis et.al., 1989) have suggested, instructional models designed to integrate hypermedia must accommodate the diverse preferences of instructional developers, a range of instructional tasks and learning situations as well as differences among learning styles.

### *References in Foreign Language Study*

The finding that bilingual dictionaries were consulted 25% more often than monolingual dictionaries assists in confirming the predictions of previous researchers (Benoussan et. al., 1984; Atkins, 1985). This is not surprising since the target language descriptions in monolingual dictionaries require some proficiency in the foreign language skills, whereas the use of a bilingual dictionary only involves translating meanings from the native language.

A more novel finding is that, even though they looked up more words, the subjects allocated a bilingual dictionary completed the reading task in 20% less time than those who used the monolingual dictionary. This indicates that the use of bilingual dictionaries expedites the reading process during foreign language learning to a greater extent than monolingual dictionaries but questions regarding their relative contribution to learning remain.

We did not elect to address the relative impact of bilingual and monolingual dictionaries on reading comprehension in this study. The notion that greater improvements in vocabulary ability will result from monolingual dictionary use seems reasonable given that the cognitive tasks are more directly associated with understanding the foreign language than when the learner uses a bilingual dictionary and cycles from one language to another. Although we did not anticipate that these benefits would be apparent over the relatively short term conditions used in this study, further research comparing the influence of monolingual and bilingual dictionary use on comprehension is recommended provided that the conditions are compared over a more extended time period and a diverse array of reading matter.

Other implications for research and practical educational benefits arose from the automated computer data collection used in this study. Computer data collection opens a diagnostic window to aspects of the reading process which

were previously not readily accessible to language educators. By incorporating hypereferences within a local computer network, instructors can easily track student performance over the course of a semester on such variables as reading time and the frequency of hypereference consultations by student. The resulting data gives language instructors additional insights for adjusting instruction to both the individual and group needs of their students.

Automated data collection on hypereferences will have even broader potential when educational institutions become linked to form a fast-path national network as advocated by Senator Al Gore (1991). Large data bases could be compiled on such variables as the most commonly looked-up words, which texts prompted the greatest number of consultations and the percentage of consultations by part of speech. This data could assist educators in teaching reading and vocabulary more effectively, aid lexicographers in improving references, and open the door to a range of research possibilities for addressing questions such as why the same word is looked up repeatedly in one passage but not in another.

Hypertext and its derivatives have been touted as revolutionary tools that will dramatically change the way humans interact with information. Results from this study indicate that at least those hypertext features which support immediate access to relevant information improve the use and efficiency of adjunct aids for reading. More research and development will be needed before the advantages of managing electronic information change information consumption to the degree they have changed information production. Even with supportive findings, the use of hypereferences may be limited for years by what Hartley (1987) describes as the chicken-or-egg problem of electronic text. That is, despite overriding advantages of the electronic information, people find it difficult to make the transition from the more familiar paper-based information. Educators should take the lead in easing this transition by supporting both the dissemination and consumption of quality instructional materials through electronic-based media.

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