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RESPECTIVE AND ADDITIVE EFFECTS OF IMAGERY AND INTERACTIVITY IN MULTIMEDIA SECOND LANGUAGE VOCABULARY LEARNING

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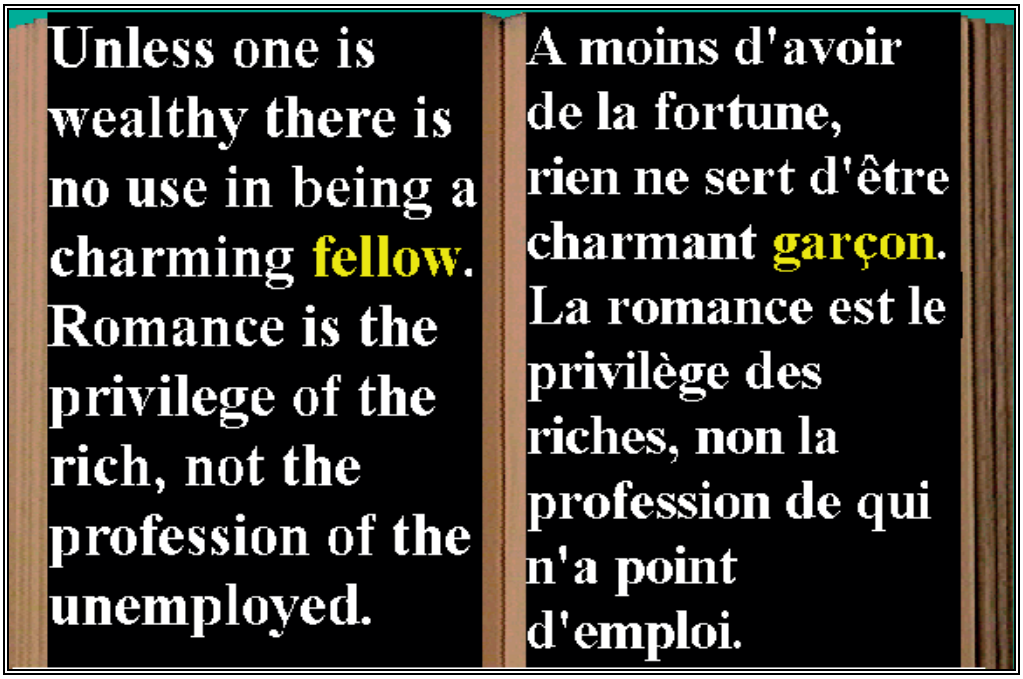
1. Introduction

1.1 Context

In a time where educational and "edutainment" software proliferates, it is worthwhile looking at the design parameters that render a teaching program attractive and, at the same time, enhance the user's learning of new material.

This study is concerned with one particular multimedia authoring program called *Memoman*. De Muralt (1992) at Symbol (Morges, CH) designed this piece of software especially for teaching foreign vocabulary in context. Its concept consists in displaying on the screen at the same time one second language (L2) text, alongside its literal first language (L1) translation; a recorded spoken version of the L2 text is synchronized with a cursor which moves from word to word, in both the L2 and the L1 text, as the text is being read out. Symbol's first CD-ROM (1996) programmed with *Memoman* featured *The Model Millionaire* by Oscar Wilde, translated from English into French. Although it was a considerable commercial success, its graphical design was still crude and its instructional effectiveness far from being optimal (cf. Figure 1.1). That is why the author approached de Muralt and proposed to carry out an experiment testing variations of the initial set-up. An agreement was reached whereby the author would research the effects on learning of including pictorial material and/or an interactive practice test to the initial voice-cursor synchronization feature.

Figure 1.1 - First screen of *The Model Millionaire* (Symbol, 1996)



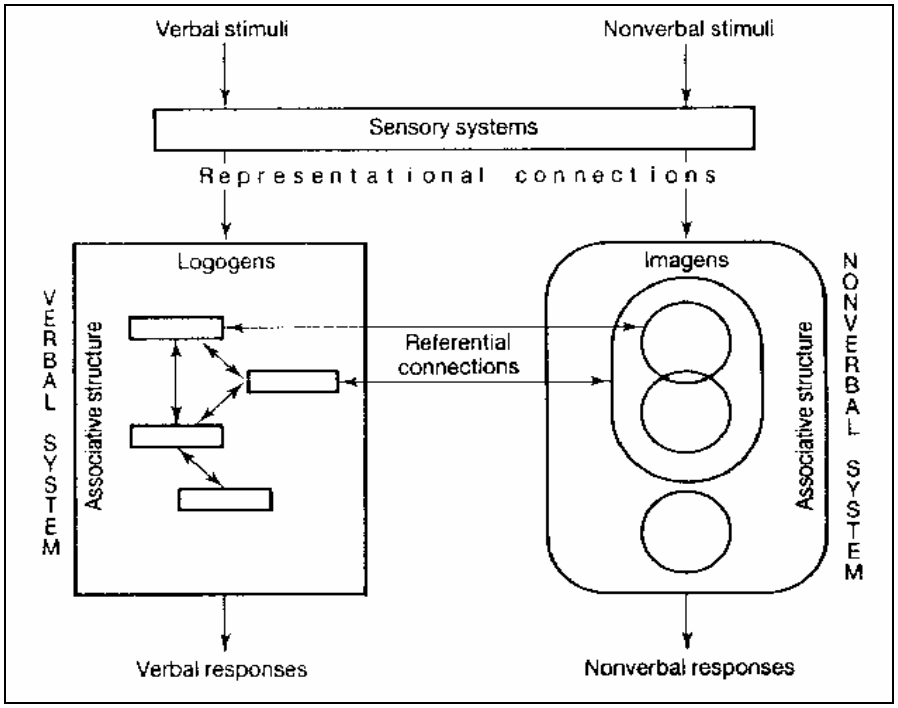
1.2 Dual-Coding & L2 Vocabulary Learning

In order to see how the *Memoman* application could be modified, it is essential to consider in detail the way we process and learn new information. The organisation of memory will therefore be considered first; this will be followed by an account of the processes involved in second language learning.

Knowledge of the world is stored in the semantic memory store (Tulving 1972). This store contains not only linguistic representations such as word meanings and referents, but also, non-linguistic pictorial representations. Despite sharing the same memory store, there is a clear dichotomy between these two kinds of representations (Paivio, 1971; Eysenck & Keane, 1992; Hasebrook, 1992). Linguistic representations are propositional in nature, hence *abstract* insofar as they do not bear a direct relationship to their object; that is, in order to understand any language, one has to be familiar with its grammar, i.e. with its set of rules. Pictorial representations, however, do not depend on a grammar to be understood. They contain modality-specific information about the physical attributes of their external objects, which makes them much more *concrete* analogies (Paivio, 1978). It follows logically that concrete nouns can be encoded in memory both in terms of their meaning and in terms of the perceptual features of their external object. Most abstract nouns, however, are only encoded semantically.

Paivio (1971) proposed a dual-coding model, suggesting that a visuo-spatial store can be dissociated from a verbal-acoustic store within semantic memory. EEG measures confirmed that linguistic and pictorial information is processed differently in both hemispheres (Hasebrook, 1992). Paivio's (1986) model distinguishes the verbal system containing *logogens* (cf. Morton, 1969) from the *imagery* system containing *imagens* (cf. Figure 1.2.1).

Figure 1.2.1

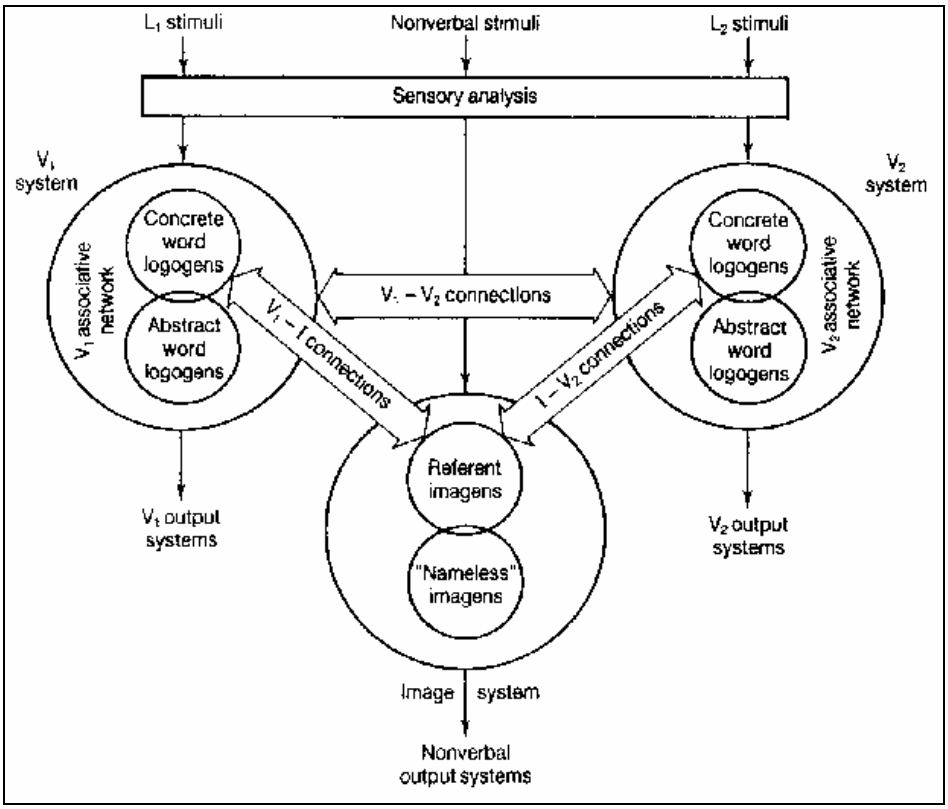


The double dissociation between these symbolic systems implies that cognitive activity can go on either in only one system or in both. Representational processing means that linguistic stimuli activate verbal representations, whereas pictorial stimuli activate imaginal representations. As the systems are interconnected, one of them can activate representations in the other (*referential level*). In addition, pictorial representations contain multicomponential information about parts of a particular object or scene, which can be retrieved from LTM by means of retrieval cues that involve any component of the whole.

Paivio's 1971 model is all the more relevant to the present study as it can be extended to accommodate additional verbal systems. That is, it also accounts for cases where an individual does use more than one language to communicate .

The model illustrated in Figure 1.2.2 (Paivio & Desrochers, 1980) presents the case of bilingualism, where a second verbal system (V2) has been included. Each verbal system therefore contains linguistically distinct representations, whereas the imagery system still deals with general, non-linguistic knowledge of the world. Again, all three systems are independent, yet partly interconnected. Accordingly, the verbal systems have referential connections between them and to the imagery system, which, in turn, mediates the access from one language to the other. Although the 1971 model indicates a one-to-many access between the verbal and the imagery system, Paivio and Desrochers (1980) argue that, in the case of bilingualism, there is a higher probability of a one-to-one access between logogens corresponding to translation equivalents. The interconnections within systems retain, nevertheless, the one-to-many type of activation.

Figure 1.2.2



In one experiment (Paivio, 1975) French-English bilingual subjects had to encode three types of stimuli: *pictures*, the English name of which they had to write down, *French words*, which they had to translate into English, and *English words*, which they just had to copy. Subjects were then asked, in an incidental memory test, to recall as many words from the experimental list as possible. In accordance with the dual-coding theory, twice as many items were recalled in the French-English translation condition (34%), as compared with the single coding in English (17%). However, recollection for pictures which subjects had to name was even better (51%). That dual-coding results in better memory performance was not new (cf. Paivio, 1973), indeed, dual-coding, as it relies on both verbal systems, implies additive effects of memory. Besides, the superior recall of pictures over bilingual, i.e. dual, coding, only confirms the general mnemonic advantage of imagery over verbal encoding (e.g. Schwartz & Reisberg, 1991). This finding also implies that concrete nouns, which are encoded both verbally and pictorially, leave a stronger memory trace than do abstract nouns.

Paivio and Desrochers's (1980) model has significant explanatory power as to the efficiency of different L2 vocabulary learning techniques. For instance, Atkinson (1975) proposed the *keyword* technique. It consists in finding a L1 keyword that bears some acoustic similarity with the L2 word to be learned, as well as in establishing an imaginal link between them. An example borrowed from Paivio and Desrochers (1980), assuming that French is the L2, would be linking the French *couteau* (knife) with the English *toe*, since the latter sounds similar to the last syllable of the French word. An associated image could be that of a knife cutting a toe off someone's foot. The acoustic similarity thus gives some information as to the pronunciation of the L2 word, whereas the formation of a mental model involving the target-word and the keyword provides clues as to the meaning of the L2 word. The keyword technique clearly takes advantage of the mnemonic superiority of dual-encoding. Similarly, Paivio (1978) proposed the *hook* technique. This strategy also relies on cued recall, since L2 words are paired with mnemonic hooks at the time of learning. Students must then try and encode a imaginal mental representation of the words interacting with each other. The main argument for the efficiency of these techniques is that by pairing a L2 word with a L1 word, one is actually generating a mental context. It is indeed a well-established finding that contextual information facilitates recall (e.g. Tulving, 1982). However, as Ellis and Beaton (1993) remark, these techniques are effective essentially for receptive learning, that is, for the comprehension of L2 words. They argue that, insofar as the production of L2 words is concerned, the most efficient method remains rote repetition. Indeed, repetition involves paying attention to both the orthographic and the phonological forms of the word to be learned. As one would expect, however, performance is optimal when these two strategies are combined.

Prince (1996) investigated whether L2 vocabulary is better acquired in context or in paired associates, i.e. in a list of L1-L2 translations. Learning vocabulary by means of translations is certainly effective, but one problem associated therewith is that it reduces the learner's L2 autonomy. Indeed, production or comprehension of a L2 word will always be mediated by the first language. Since lists generally consist only of verbal material, the imagery system will not be activated, i.e. no advantage can be taken of dual-coding. Moreover, if this verbal memory trace is not reactivated, it will decay or be disrupted by other traces (Baddeley, 1990). Alternatively, the information can be stored in LTM, but not readily retrieved for use in the appropriate context (Wiseman & Tulving, 1976). Nation (1982) reports that research has generally failed to show an advantage of learning vocabulary in context over learning using the

paired associates method. This can partly be explained by the fact that context does not always provide sufficient clues to infer correctly the meaning of L2 words (Hulstijn, 1992). When it comes to L2 teaching, presenting vocabulary in context is all the more important. Indeed, if the context is authentic, it shows the learner that the words s/he must learn are indeed used, and how they are used. Prince (1996) concludes that determining the meaning of a L2 word in context may also involve accessing the word's stored translation, so that, at the end of the day, both learning methods are not mutually exclusive. Put differently, extracting meaning from context is an activity where "top-down and bottom-up processes are highly interwoven" (p.488). A drawback of the translation method is its assumption that every L1 word can be adequately linked to a L2 word, i.e. in a one-to-one correspondence. Accordingly, what really should be taken into account when teaching L2 vocabulary is the learner's metacognitive learning strategies (Oxford, 1990). Indeed, strategies that the learner finds relatively effortless in the first place may result in poorer L2 retrieval and production skills.

Besides, in order to maintain newly acquired knowledge, it is essential to maintain access to that information in memory, which Bjork (1988) refers to as *retrieval practice*. Indeed, this implies that practice with retrieval will facilitate a subsequent effort to retrieve. Therefore, it can also be used as a powerful mnemonic technique. Retrieval practice, Bjork (1988) argues, is implemented most efficiently when an almost immediate first rehearsal follows the learning event; this should then be followed by additional rehearsals at increasing delays. This is referred to as *spaced* or *distributed* practice, as opposed to *massed* practice where sheer rote repetition occurs only once (cf. Baddeley, 1990). Rea and Modigliani (1988) report that the superiority of spaced over massed practice in terms of learning has indeed been observed outside the laboratory, such as in L2 learning situations.

Therefore, the *Memoman* approach combines in a single media set-up both one-to-one translation and context learning. This facilitate the formation of referential connections between logogens in the V1 and the V2 systems on one hand, while giving contextual information as to how the word is used on the other. However, there is no opportunity for imaginal representation in Symbol's first product, due to the lack of imagery. Paivio's (1971; 1980) models suggest that the inclusion of pictorial material will give rise to imaginal processing and the subsequent formation of referential links between the imagery store and the verbal systems. In addition, the initial *Memoman* set-up does not provide any opportunity to rehearse the newly acquired information. However, it has been shown that immediate rehearsal is crucial for subsequent recall.

1.3 Multimedia & Multimodal Processing

Since the advent of television in the 50s, a great many studies have been carried out to investigate to what extent mediating technologies could be used in the educational setting (Romiszowski, 1988). Nowadays, most research in educational technologies is concerned with the multifaceted capabilities of multimedia. The main question remains: Which media combination is best for learning? Now that any combination of text, sound, still and animated pictures is technically possible, it is imperative to consider their effects on motivation, comprehension, encoding and retention. Experimentation in this field is all the more important as the assumption that more

media results in better learning has often be shown to be mistaken (Haselbrook, 1992). Indeed, in a situation where one is presented, say, with text, animation, spoken text and music, it is very likely that concurrent stimuli will give rise to interferences in STM sensory stores. Such processing limitations are referred to as divided attention (Eysenck & Keane, 1990). Indeed, the capacity of STM or working memory is limited, so that one can only attend to a certain amount of stimuli at a time (Baddeley & Hitch, 1974). In addition, STM is known to be affected by *selective attention*, which refers to a conscious choice of the stimulus to attend to (Sperling, 1960). Different media combinations will now be discussed.

Text & Imagery Vernon (1953) compared text comprehension of a group which was presented only with text with a matched group whose text was illustrated pictorially. The illustrated version was not found to be better understood. However, those points that were illustrated with a picture were better remembered, although general text comprehension was reduced accordingly. According to Romiszowski (1988), the effect of illustrations on comprehension is minimal when the text *per se* is sufficient, i.e. when pictures do not provide additional information. Besides, this author also suggests that better-educated people understand and interpret pictorial material more readily since they have more experience dealing with pictures and graphs. Less educated people, on the other hand, find it more difficult to process visual information so as to use it to answer a written question (cf. Duncan & Hurtley, 1969). A meta-analysis of text illustration on comprehension was carried out by Levie and Lentz (1982). They report that 46 studies replicating Vernon's (1953) do, in fact, show opposite results. That is, relevant illustrations that just repeat information found in the text do facilitate learning, understanding and recall (e.g. Glenberg & Langston, 1992). Also, there are many cases where linguistics symbols are not the best way to convey information; that is, illustrations can sometimes be worth "a thousand words" (Mayer & Sims, 1994) and thus act as substitutes for words. As predicted by Paivio's 1980 model, Gagné (1985) argues that the effect of illustrations on retention is particularly strong when pictures are combined with pairs of words, as is indeed the case in most L2 vocabulary learning situations. Last but not least, even when illustrations do not add any new information, it has been observed that they have a motivating effect, which renders reading more enjoyable. As illustrations can provoke emotional reactions, the reader is more likely to put more efforts in understanding what is being communicated (Levie & Lentz, 1982; Glenberg & Langston, 1992).

Text & Sound Jakobsdottir & Hooper (1995) investigated the effects of written and spoken text in a multimedia computer-assisted language learning (CALL) situation. Their main finding was that presenting congruent text with spoken words facilitated the acquisition of listening skills. Indeed, subjects who had either no text and sound, or text and no sound made significantly more errors in a comprehension posttest. Presenting text contiguously with words thus helps students discriminate between individual words, which facilitates bottom-up processes in comprehension. Besides, audio is an essential characteristic in L2 learning since it helps learn the correct intonation and pronunciation of L2 words (Romiszowski, 1988).

Text, Imagery & Sound In a multimedia learning situation, subjects were asked to learn the functioning of either a bicycle tire pump or a car breaking system by

means of animated images, text and oral descriptions (Mayer & Anderson, 1992). Four experimental conditions were tested: sound and animation at the same time, successive presentation of narration and animation, animation alone and narration alone. A control group was given no instructions at all. When retention of the material was tested, it appeared that all four groups performed better than the control group, but that they did not differ significantly from one another. In line with the dual-coding theory, subjects in the treatment groups were encouraged to build representational connections between words and verbal representations, and between pictures and visual representations, which explains their high retention rate. In problem-solving tests, however, it was found that the group in which oral narration and animation were concurrent performed significantly better than all the other groups. As in the Jakobsdottir and Hooper (1995) case, it is the contiguity in time and space of visual and auditory stimuli that allows for the most meaningful form of learning. Indeed, in addition to the representational connections, subjects in this group could also build referential connections between their verbal and visual representations. In an extension of this study, Mayer and Sims (1994) found that high-spatial ability learners have more facility building the referential links than low-spatial ability learners. It should be noted that Mayer and colleagues (1992; 1994) used only material that explained how a system works. It is therefore questionable whether the same observations could be made in the instances of descriptive or narrative texts, or indeed in L2 vocabulary learning situations.

A recent study by van der Molen and van der Voort (1997) showed that children from 10 to 12 years absorb more information from television than from the printed word. This is all the more surprising in view of the fact that adults learn better when studying printed information. Of the 152 schoolchildren, half received the information in the original televised format, while the other half were given a printed transcript of the story. In a memory test, the TV group, which had been presented with the program only once, answered 51% of the questions correctly, whereas the other group, which could read the transcript as long as required, got an average score of only 42% correct. This finding confirms the claim that illustrations which convey the same meaning as the written or indeed, spoken test can facilitate learning. Besides, it also points to the fact that children are very comfortable with audio-visual media, in that they know how to decode images and draw inferences (van der Molen & van der Voort, 1997).

Barrás and Lafayette (1994) analysed to what extent the inclusion of L2 subtitling in a video recording (i.e. text on image and sound) would affect the comprehension and speaking performance of college students. Opponents to the use of subtitles in CALL contend that they are more distracting than helpful, and that they slow down the development of listening skills. However, Barrás and Lafayette (1994) found that intralingual subtitles help the learner associate the phonology of words with their written form, which leads to better comprehension. Moreover, subtitling was also found to help produce more accurate L2 output. The best results are obtained when the learners can control the speed at which the video and subtitles are presented. This leads us to the next section which deals with the importance of *interactivity* in multimedia education.

1.4 Multimedia & Interactivity

The obvious advantage of multimedia over print or video lies in the interactivity possible between the learner and the machine. It is often argued, however, that most multimedia teaching packages do not take into account current theories about cognitive Psychology, and human-computer interaction (Romiszowski, 1988; Morgenstern, 1992). The main objection is that most programs allow for very limited learner input, despite the fact that two-way interaction can already be realised to a non-negligible extent. It is not the ambition of computer-based teaching by any means to replace traditional teaching. It should more be regarded as an aid for learning, which may even present information that cannot be communicated by a teacher (e.g. bird songs, symphonies, specific L2 accents, etc.). Besides, it is assumed, as commonsense would suggest, that practice makes perfect and that the more interactivity between the learner and the machine, the more it will resemble real one to-one tuition. An obvious advantage of computers is their ability to repeat exercises and commands at will and, what is more, in a nonjudgmental way (Morgenstern, 1992).

When considering the learning process alone, the most common interactive feature is the possibility for the learner to resort to electronic help glossaries where answers to specific questions can be found. However, we shall focus our attention more on interactive assessment and feedback. The most prevailing form of interactive tests has been referred to as *drill-and-practice* tests (e.g. Zinn, 1978; Hockey, 1987; Pennington, 1989). Such tests usually present learners with questions and sets of answers, and require them to indicate the correct answers. Most of the time, drill-and-practice tests take the form of multiple-choice questions. Some cast doubt on the pedagogical soundness of such tests. Indeed, by presenting several incorrect alternatives, they encourage the learner to process as much the correct as the wrong answers, which may thereby reinforce wrong question-answer associations in the learner's memory (Picciotto *et al*., 1989). Besides, simple forms of multiple-choice tests even allow for the learner to guess an answer, i.e. it is possible to perform well even though one has not really understood the subject matter.

There is some evidence, however, that drill-and-practice tests, for instance, in mathematical skills (Suppes *et al*., 1968) and L2 learning (cf. Pennington, 1989) develop higher levels of competence in less time than more traditional methods of instruction. These positive effects of drill-and-practice tests should be taken with circumspection, since other studies in L2 learning failed to show a significant difference in performance between groups using CALL and groups which were given ordinary instruction (Pennington, 1989). This can partly be explained by the fact that students regard the constant repetition of one activity as little motivating, and therefore lose interest, which has obvious effects on attention and memory (Self, 1985; Nagata, 1993).

Research in Artificial Intelligence (AI) has had a considerable influence on the design of better computer-based instruction programs. Adaptive systems have been a major innovation since the basic drill-and-practice programs (Cooper & Lockwood, 1979; Romiszowski, 1988; Hasebrook, 1992). Typically, at the start of a session, the computer would ask the learner to answer some personal questions in order to establish his or her profile, i.e. state of knowledge, age, interests and other relevant information. The computer then uses these data to determine which questions it will ask. Once a question is completed, immediate and user-targeted feedback is given, i.e. mistakes will be explained in detail (e.g. Gagné, 1985). When the learner repeatedly fails

to answer certain questions, the computer will present him or her with more questions of equivalent difficulty before moving on to the next level. Avoiding thereby excessive mistakes on the part of the learner will undoubtedly have a motivating effect (Romiszowski, 1988).

In addition to the innovations discussed above *intelligent tutoring systems* also incorporate AI principles of two-way interaction (e.g. Hasebrook, 1992). Unlike multiple-choice tests where one answers by indicating the correct answer, intelligent tutoring systems allow for more input on the part of the learner. This implies that, for such a system to be effective, it must be programmed to anticipate students' responses. For instance, the well-known AI program called ELIZA (Weizenbaum, 1966) simulates a written conversation between a psychotherapist and his patient. However, once one leaves this specific therapy situation, the performance of the program is seriously undermined, due essentially to its lack of common-sense (Brown, 1986). Its *a priori* advantage lies in the fact that it can provide even better help and feedback. However, the programming of such systems is very complex and time-consuming, which explains that they are still very rare. In reality, Romiszowski (1988) argues, intelligent tutoring systems are still in the process of being developed, and are therefore more to be found in research laboratories than in classrooms.

1.5 Predictions

It is hypothesized, on grounds of the dual-coding theory and the benefit of immediate feedback, that the inclusion of either and both images and an interactive practice test will lead to better memory performance than the initial *Memoman* set-up. In addition, it is predicted that the inclusion of both images and interactive test will have additive effects, i.e. that learning in that condition will be more effective than in the two simpler experimental conditions. However, insofar as imagery and interactivity are concerned, their respective effect sizes can only be determined empirically.

In order to test these predictions, three new variations of the initial *Memoman* set-up will be created, which incorporate the imagery and interactivity components. Thus, the same information will be presented in different media combinations to three treatment groups and one control group. The control group will be presented with the original *Memoman* set-up. The first experimental group will have illustrations next to the text, while the second will be allowed some practice by means of an interactive test. The third experimental condition will consist of both the imagery and the interactivity components. Besides, it is the experimenter's arbitrary choice to carry out the experiment with a L2 stimulus text in French. Accordingly, subjects must all have some basic knowledge of that language.

2. **Method**

2.1 Design

Knowledge of French vocabulary is first assessed by a multiple-choice test. In order to see which variables most affect the learning of L2 vocabulary in a multimedia-based instructional event, subjects are randomly allocated to one of the following conditions, the independent variable being the multimedia set-up:

1. *Control condition*. The stimulus consists of recorded text synchronised with a moving cursor in both the French and the English texts.
2. *Imagery condition*. In addition to the sound-cursor feature, each target words has been associated with a pictorial image. The image appears as a particular word is being read out and stays on screen between 1 or 2s.
3. *Interactivity condition*. The stimulus consists of control condition 1, followed by a computerised interactive practice test in a multiple-choice format.
4. *Imagery & Interactivity condition*. This condition is henceforwards referred to as Im&Int condition. It combines conditions 2 and 3. The stimulus therefore consists of voice-cursor synchronisation, images for the 50 target words and the subsequent practice test.

After the instructional event, subjects complete the same multiple-choice test again (immediate posttest). Subjects have only one trial. The dependent variable is the increase in performance, expressed as a percentage (cf. *3.1 Measures*). This relative measurement allows for flexibility as to the initial levels of vocabulary knowledge. It is a between-subject design as one is only interested in the differences in newly acquired vocabulary between the 4 conditions.

2.2 Subjects

Subjects were allocated randomly to the four conditions, and care was taken to ensure that the treatment groups were of similar size. 46 subjects were tested in this experiment. Since 5 participants performed at ceiling in the posttest, only 41 subjects, 21 males and 20 females, are considered for analysis. Thus, group sizes are 9 (Control), 12 (Imagery), 10 (Interactivity) and 10 (im&int). Age ranged from 19 to 72 years (mean: 28.2, St.d: 9.7). Approximately 75% of the participants were in employment and were taking French evening classes at The City University (Adult Education) at the time of testing. The remaining 25% were students at The City University who had taken French lessons in the 5 years preceding the test. Participation was voluntary.

Figure 2.3.1 - New Screen Layout: Example of Illustrated Text

2.3 Apparatus and Materials

The pretest and the posttest consisted of the same paper-based set of 50 multiple-choice questions (1 correct answer for 3 foils). Approximately half of the words, all drawn from the L2 text, were concrete nouns (26). The rest were abstract nouns (6), verbs (7), adjectives (6) and expressions (5) (cf. Appendix A). The pretest contained three additional questions concerning the subjects, namely age, gender, and the time they had been studying or had studied French for.

The 4 experimental conditions were created by the author using the *Memoman* authoring package: that is, *MemoText* to create the layout of text and pictures on the screen, *MemoShow* to synchronise the spoken with the written text, and *MemoPlay* to run the instructional application.

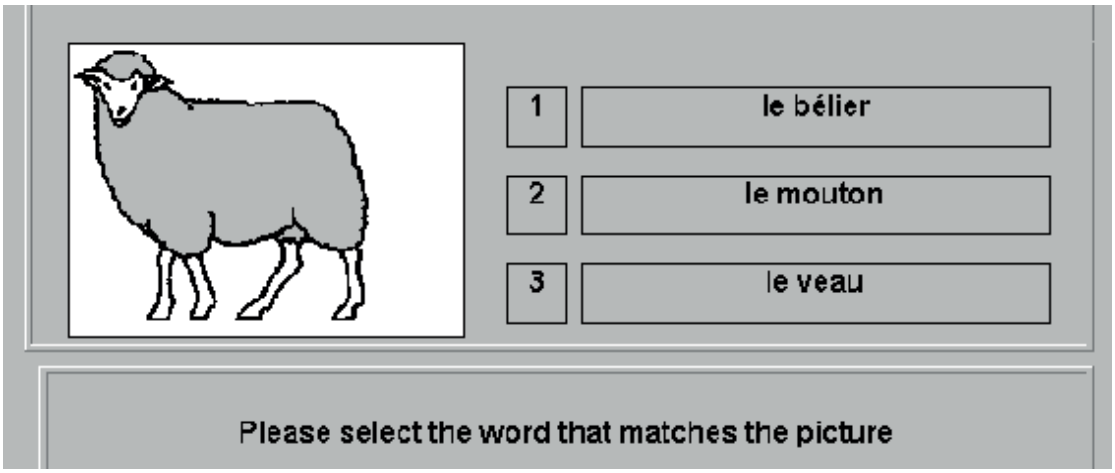
This application was designed so that the screen was split up in three columns. Unlike the original *Memoman* set-up where the second language text was on the left, the L2 text was in the middle column. This was to shorten eye-movements between the L2 text, its L1 translation on the left hand side and the occasional images (according to the condition) on the right hand side (cf. Figure 2.3.1). In addition, the cursor was made more visible (red letters on white background) to highlight even more the corresponding pairs of words or phrases.

The L2 stimulus consisted of the original, unmodified first two chapters of Antoine de Saint-Exupéry's *Le Petit Prince* (1943) (cf. Appendix C). The L1 translation, inspired by Woods (1945), was nevertheless modified by the author for greater literal clarity (cf. Appendix D). The L2 text was read out by a native French teacher. The re-

cording was then edited with *WavEdit*. The subjects used headphones to listen to the text in the experimental event, which lasted 9.0 minutes.

Most of the 50 images for conditions 2 and 4 were drawings found in language teaching textbooks or in *Microsoft Office*'s Clipart; some were drawn by the author. All pictures were modified in size and colour using *Paint Shop Pro*.

Figure 2.3.2 - Example of Question for Type A (image)



The interactive test for conditions 3 and 4 was created in *Visual Basics*. Each question was presented in a multiple choice format with 2 foils. It contained 48 of the 50 target words, equally divided into four different types of questions (cf. Appendix E):

a. An image with three words in French (cf. Figure 2.3.2)
b. An English word with three words in French.
c. A French word with three words in English.
d. A French sentence with one or two blanks alongside three words or pairs of words in French.

At the beginning of the practice session, subjects are presented with the following message on the screen: "Press the SPACEBAR or click on START to begin". Questions of type b and c were accompanied by the instruction "Please make your selection", picture-questions, by "Please select the word that matches the picture" and blank-questions, by "Choose the word(s) that fit(s) the blank(s)". The questions were presented individually, so that one question had to be answered correctly in order for the next one to appear on the screen. Selection could be done either by clicking on the word or on the box surrounding it, or by typing the corresponding number (1, 2, or 3) on the keyboard. Selection of wrong answers elicited a beep and a message reading "Wrong - Try again". When the correct answer was selected a message reading "CORRECT" was displayed and remained for 1s before the next question was presented.

2.4 Procedure

A pilot study was first carried out to assess the difficulty of the vocabulary test used as pretest and posttest, so as to avoid potential floor or ceiling effects. The paper-based multiple-choice test was distributed to 13 students taking French lessons at the Immediate or Advanced levels. Those students were not allowed to volunteer as subjects in the proper experiment. It turned out that the test was very easy for most of the students. As a consequence, the questions were made more difficult by replacing obvious foils by semantic and/or phonological distractors. Besides, it was decided that the test should be carried out with students at the Beginners and Intermediate levels.

Subjects were tested individually or in groups of 2, with each subject allocated to a computer with multimedia facilities. Each subject was randomly assigned to a treatment group. First, subjects had to complete the pretest, i.e. 3 personal questions and 50 multiple-choice questions. They were told that it was a general vocabulary test to assess their level; no information was given at that time as to the subsequent experimental event. The completed tests were then collected by the experimenter. Second, the experimenter told the subjects that they were to be presented with a CALL application. To minimise experimenter effects, each subject was given exactly the same instructions. Namely, that the computer screen is divided into three columns, the middle column containing the original L2 text, the left one, the L1 translation, and the right one, occasional pictures, according to the treatment condition. Participants were told that their aim is to learn as many new L2 words as possible. Therefore, they were asked to concentrate on the written and spoken versions of the L2 text, and to look at the L1 text only to check a particular translation. Unknown to them, they were to encounter all 50 target words appearing in the pretest in the instructional event.

Subjects had to start the *Memoman* show of *The Little Prince* that corresponded to their treatment group by pressing the spacebar. After the multimedia show had finished, subjects in the Interactivity and Im&Int conditions were told to start the interactive practice test, the 48 questions of which they could complete without any time limit. Performance on this test was not recorded.

Thus, the time involved in learning for subjects in the Control and Imagery groups was 9.0 minutes, whereas it was approximately 12 minutes for subjects who had to complete the interactive practice test. Subjects in the Control and Imagery conditions were asked to complete the pencil-and-paper posttest straight after the multimedia show. This test had also to be completed once subjects in the former groups had finished the computerized practice test.

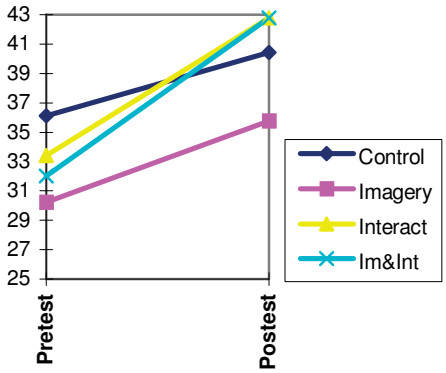
3. Results

3.1 Measures

Vocabulary knowledge is quantified by means of the pre- and posttests. The scores correspond to the number of correct answers. Scores can therefore range from 0 to 50.

An ANOVA revealed that the *pretest* scores do not differ significantly between conditions. (cf. Appendix G1). It therefore seems as though one could measure the dependent variable as the difference between the posttest score and the prestest score. However, this was not judged appropriate, since it would not take into account the subject's initial level of vocabulary which this difference is relative to. Figure 3.1 and Table 3.1 show the mean pretest and posttest scores. It is evident that there are some non-negligible, albeit not statistically significant, differences between the pretest scores. Accordingly, a relative measure of performance should be preferred, since it reflects much more accurately a subject's amount of learning.

Figure 3.1 & Table 3.1 - Mean Pretest and Posttest Scores



Condition	Scores (Out of 50)	
	Pretest	Posttest
Control	36.11	40.44
Imagery	30.25	35.75
Interact	33.40	42.80
Im&Int	32.00	42.80

The dependent variable is therefore the increase in performance (%), as measured by the difference between the pretest and the posttest scores, divided by the pretest score and multiplied by 100. That is:

$$Increase\ in\ Performance = \left(\frac{posttest - pretest}{pretest} \right) \times 100$$

3.2 Preliminary Analyses

The mean increase in performance (%) for each condition, as well as the mean increase minus the baseline value (control condition) for the experimental conditions are reported in Table 3.2. *Count* refers to the number of subjects in each condition. The mean effects are measured in *points*, i.e. in differences between two percentages.

Table 3.2

CONDITION	COUNT	MEAN INCREASE IN PERF. (%)	ST. D.	MEAN EFFECT (POINTS)
control	9	**13.67**	11.85	**0**
imagery	12	**22.89**	17.76	**9.22**
interactivity	10	**32.60**	21.85	**18.93**
im. & int.	10	**34.89**	16.20	**21.22**

The mean values for the control condition reflect the increase in performance using the initial *Memoman* setup.

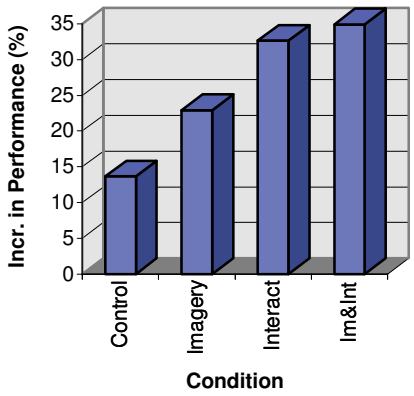
The inclusion of pictorial material (imagery condition) results in a increase in learning of approximately 9 points.

With the inclusion of an interactive practice test (interactivity condition), performance increases by ca.19 points.

It was hypothesized that the respective effects of 9 and 19 points would add up in the combined condition. However, the effects of Imagery & Interactivity amount to only 21 points.

Figure 3.2 shows a graphical representation of the results, which will be analysed and commented in detail in the Discussion.

Figure 3.2
Mean Increase in Performance (%)



3.3 Additional Findings

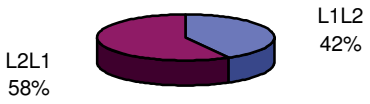
Half of the questions in the pretest/posttest asked for the meaning of a French word, while the other half required subjects to choose the correct French translation of an English word. These two types of questions are referred to as questions asked in the L2-L1 and L2-L1 directions, respectively.

As far as the pattern of errors in the pretest is concerned, significantly more errors occurred in the L2-L1 direction (58%), as compared with the L1-L2 direction (42%). This is illustrated in Figure 3.3:

The proportions of errors in the posttest do not differ significantly from those in the pretest, despite their being produced after different experimental conditions: the values range from 55% L2L1/45% L1L2 for the Imagery and the Interactivity groups to 60% L2L1/ 40% L1L2 for the Im&Int group.

The reasons behind this pattern of results will be analysed in the Discussion.

Figure 3.3
Proportions of Errors
In Terms of Direction (Pretest)



` Table 3.3 shows the proportions of errors made in the posttest for those treatment groups which had to complete the interactive practice test beforehand. No further analysis was carried out on these data. Question-type refers to the way the multiple-choice questions were designed (cf. *2.4 Procedure*).

Table 3.3

	PROPORTIONS OF ERRORS (%)	
QUESTION TYPE	*Interactivity Cond.*	*Im&Int Cond.*
L2 word	**11.5**	**11.5**
L1 word	**31.1**	**23.1**
Image	**18.0**	**25.0**
Blank	**39.4**	**40.4**

In both conditions, the greatest proportion of errors were made when the target word was presented in a "choose the word(s) that fit(s) the blank(s)" type of question, i.e. where subjects had to understand a L2 context. In addition, least errors were made in the posttest when the target word had been presented in French (L2). The two treatment groups differ in their proportions of errors in the L1 word and Image question types. Whereas subjects in the Interactive condition made performed better with images than with L1 words, the opposite pattern of results is observed in the Im&Int group. The implications of these results will be considered in the DIscussion.

3.4 Statistical Analysis

A correlation table (cf. Appendix G2) showed that age and sex did not correlate with the two measures of performance. However, the table indicates a significant correlation between pretest scores and the subjects' differences between the posttest and the pretest. Therefore, it confirms that the relative measure of performance should be preferred since it controls for differences in the pretest score, so as to avoid effects due the initial level of L2 vocabulary knowledge.

The data analysis was carried out using the SPSS/PC package, with a preselected Type I error of $\alpha = .05$. A One-Way ANOVA was carried out to test differences in increase in performance between conditions (cf. Appendix G3). A significant effect of the independent variable was observed: $F(3, 37) = 2.9696$, $p<.05$. A post hoc test, the Least-Significant Difference test indicates that only the control condition differs significantly from the two interactive conditions.

4. Discussion

The data collected in this experiment support the hypothesis that the inclusion of both images and an interactive practice test (Im&Int condition) results in significantly better memory performance as compared with the control group. A significant difference in performance is also found when the initial *Memoman* set-up is followed by the interactive test. However, the observed difference in performance between the control and the Imagery groups is not statistically significant.

4.1 Theoretical Implications

The main findings will now be analysed from a theoretical viewpoint. As far as the effect of imagery is concerned, it is observed that text illustration leads to slightly better learning performance. Although the effect is not statistically significant, it nevertheless points to a beneficial effect of non-verbal material in the learning of corresponding verbal representations. This supports Paivio's (1971; 1980) dual-coding theory in that the imagery system provides additional referential connections and helps thereby mediate translations between the verbal systems. However, this non-significant result adds to the theoretical debate about the usefulness of text illustration. Vernon (1953) reported an increased learning performance for the illustrated points, at the expense of general text understanding. In the study reported in this paper, subjects encountered 50 illustrated points, which implies that imagery had a great influence on general text comprehension. In this respect, the non-significant effect reported here could be compared to that observed by Vernon's (1953). One should bear in mind, all the same, that Levie and Lentz (1982) reported facilitated learning effects of text illustration, even when they were text-redundant. It seems fair to argue that the stimulus text in this experiment was a piece of literature, and that, accordingly, illustrations were by no means essential to understand it. That relates to observations made by Mayer *et al.*'s (1992; 1994) studies. Indeed, they argued that still or animated illustrations are certainly more beneficial when the subject matter demands non-verbal descriptions (e.g. mechanical systems) than when they only repeat the same information (e.g. literature). Besides, one should not overlook the distracting effects illustrations can have for some subjects (cf. *4.1. Methodological Remarks*). All in all, it is reasonable to argue that images *should* be included in printed text or multimedia presentations, due to their motivating and cognitively stimulating effects. Indeed, one is so used to seeing pictorial illustrations everywhere that a book or a computer program that deals only with verbal material will certainly count as little motivating and indeed, dull.

This study showed that interactivity was a crucial element in multimedia learning. Indeed, it was the only factor that led to statistically significant differences in performance. This is hardly surprising as the interactive practice test was an additional learning opportunity wherein it was possible to assess and improve one's state of knowledge. This finding therefore supports the claim that practice makes perfect. In this case, practice with L2 vocabulary helped reinforce the referential connections between corresponding words in the learner's French and English language systems. Besides, insofar as practice implies one's active involvement, it seems that the more opportunities for interaction between the learner and the machine, the better new material will be processed and remembered. It was the experimenter's decision to present

the interactive test in a multiple-choice format, since the facility of its technical realisation overweighed the instructional deficiencies associated with it. However, it is remarkable that even a test as little elaborate as a multiple-choice test leads to such a difference in performance. There is little doubt that more adequate forms of interactivity in the assessment process will lead to even better learning. As for the learning process, it is noteworthy that commercial *Memoman* applications allow to work through the text at one's own pace as well as to run the program on its automatic mode. This entails that the experimental event was made artificially more difficult since subjects had no control of the speed of presentation. As the findings of Barrás and Lafayette (1994) demonstrate it, the learner's active control of the rate of presentation has also beneficial effects on learning performance. Therefore, L2 vocabulary learning with *Memoman* applications in real world does in fact result in much greater rates of learning than what is reported in this study.

When imagery and interactivity are combined, it is interesting to note that their respective effects are additive only to a certain extent. The increase in performance is greater than in the Interactivity condition alone, however, this difference is not statistically significant. This result is consistent with the non-significant effect of imagery as compared with the control group. Besides, one should not overlook the fact that posttest results for the Interactivity and Im&Int groups tended towards the limits of the experiment, i.e. towards a ceiling effect. Indeed, this explains why it is more likely to see a significant improvement in less elaborate conditions than in conditions were the rate of learning is significantly greater.

4.2 Additional Observations

4.2.1 Proportions of L1L2 & L2L1 Errors

It was observed that more errors in the pretest were made when the target word was presented in the L2. This is a common observation amongst teachers and can be explained quite straightforwardly. Indeed, in a multiple-choice test, it is much easier to spot the correct answer amongst several L2 words, since it is generally more familiar to the learner than the semantic or phonological distractors. On the other hand, choosing the answer from a set of L1 words is less easy, since the learner is familiar with all those words. This task requires one to have well-established one-to-one referential connections between corresponding propositional representations in the two verbal stores. It is most remarkable that the proportions of errors in the posttest are equal. Indeed, one would expect performance in the L2-L1 direction to improve after the instructional event where the L2 target words are heard and seen in context.. It should not be excluded that a potential confounding effect due to the choice of words presented in either direction might have biased the data.

4.2.2 Interactive Practice Test

As for the respective effectiveness of the different types of question in the computerised test, it is observed that presenting the target words in the L2 in the practice test is most beneficial for learning. This relates to the point made earlier about familiarity of L1 answers. The least beneficial form of practice is when the learner is required to process a L2 context in order to choose which words fit the blanks. This is most surprising in view of Craik and colleagues' (1972; 1975) *Levels* and *Elaboration of Processing* theories, which state that both depth and elaboration of processing have a positive effect on an item's memorability. Indeed, one would assume that extracting information from contextual clues requires considerable top-down processing and active involvement of semantics, which would certainly rank as *deep* and *elaborate* processing. It is hypothesised that subjects found it precisely too deep to process, so that they just tried to get to the next question using a little elaborate trial-and-error strategy.

As far as the two other question-types are concerned, an opposite pattern of result is observed between the two Interactivity groups. Subjects in the Interactivity condition made less errors in the posttest when the words were presented to them in a *image* than in a *L1 word* type of question. The peculiarity of this pattern of results lies in the fact that, *a priori*, those tasks were quite similar, since, in both cases, subjects were required to choose the correct answer among a set of L2 word. Therefore, this cannot solely be accounted for by the subjects' greater familiarity with the correct L2 answer. It is much more a matter of using different referential paths: from a verbal representation to another verbal representation (L1 word questions), or from an imaginal representation to a verbal one (image questions). In the former case, translations can be mediated by the imagery system, whereas they are direct in the latter case. The results would suggest that practice with non-verbally mediated material results in better learning than practice with verbal L1 questions. However, subjects in the Im&Int condition showed a slight learning advantage for L1 word questions over image questions. Although this difference is small, it is interesting to observe that having been presented with the pictorially illustrated text leads to proportionally more errors to be made with image questions. It remains that the observations about image and L1 word questions should be taken more as anomalies due to the test questions than as truly representative empirical findings.

4.3 Methodological Remarks

It is noteworthy that the study reported in this paper is undoubtedly more naturalistic than strictly experimental. This implies that a number of extraneous variables which could not be controlled for might have played a non-negligible rôle. This is primarily due to the impossibility of assessing a person's precise state of L2 knowledge. The pretest scores were taken into account in the data analysis, however, it is indeed very questionable whether they are reliable indicators of one's knowledge of vocabulary. Subjects with similar pretest scores may have had a dissimilar amount of formal tuition or experience in a French-speaking environment, which would have affected their performance on the posttest. Since most of the subjects were taking language courses at the same level at the time of testing, it is nevertheless argued that such effects have been kept as minimal as possible.

Some subjects remarked that the pace of speech in the experimental event was too fast; that is, they could not properly focus their attention on the spoken and written L2 text, while, at the same time, checking the L1 translation, and paying attention to the occasional images. It may be that those subjects got somewhat distracted by this wealth of stimuli, and that they lost some bits of the story in order to follow the spoken text. This implies that some subjects may have had more experience with audio-visual instructional media than others. This, of course, would have had some repercussions on their performance. It seems fair to assume, however, that most of the participants missed the occasional word or expression. It was indeed the experimenter's decision to present the subjects with the *Memoman* application in the automatic mode, that is, where it was not possible to work through the text at one's desired speed. This was to avoid ceiling effects due to the posttest being too easy to complete on one hand, and to avoid additional confounding variables, such as time spent studying the stimuli on the other.

Besides, it was certainly the case that several images used to illustrate the target words appeared and disappeared within one second, which was not enough to process, interpret and comprehend them. Since they were drawings taken from different sources, one had occasionally to adapt to new drawing styles. Also, some pictures turned out to be quite ambiguous or even ill-adapted to the context of the word being illustrated.

The only criticism one might raise about the interactive practice test is that it came after the *Memoman* show, that is, subjects in relevant conditions had simply more time and more opportunity to learn new material. It is therefore commonsensical that they should perform better. In addition, the time taken to complete the test was not taken into account.

As for the testing procedure, there is little doubt that the pretest had some priming effects. This led most of the participants who realised that all the target words appeared in the experimental event to look primarily for them, which conferred a mnemonic superiority upon those words. That is, the target words were paid more attention to, at the expense of the other words occurring in the stimulus story and of the general text comprehension. However, there was no other reasonable way to assess one subject's initial vocabulary knowledge and, although priming did most certainly occur, it does not have any implication on the validity of the results. Besides, it may be objected that a recall test would have been more adequate than a recognition test in assessing the rate of learning. Although multiple-choice tests allow for guesswork,

they can be marked easily and most objectively, unlike recall tests, where marking is much more ambiguous. The most serious objection, however, is that no delayed post-test was administered in order to analyse long-term effects of imagery and interactivity.

However, given the concrete nature of the study, it is argued that every care was taken to gather data that reflect true learning performances *in situ*. This is valuable by itself and should not be neglected for the methodological flaws which this implies.

4.4 Further Research

Multimedia learning encompasses so many different sorts of stimuli that continuous research in this domain is absolutely essential. Considering only the *Memoman* set-up, much more research could be done about the variables at issue in this experiment. One could investigate whether the inclusion of a lesser number of images that are unambiguous to interpret and generally better adapted to the story affects learning. Besides, it would be interesting to design an application such that it contains graphical illustrations that do *not* illustrate information conveyed by the text, yet render the screen more pleasant to look at. If a significant difference in learning is found between the *Graphic* group and the control group, this would point to a pure motivational effect of imagery. Insofar as interactivity is concerned, it would be worthwhile investigating whether more elaborate types of interactive tests, such as simulations, games, etc. result in a different rate of learning compared with the simpler multiple-choice test.

5. Conclusion

This study has tested three variations of the initial *Memoman* set-up. It was found that the inclusion of images improves learning, but not significantly. However, it is argued that pictorial material has a motivating effect, and that, for this reason, images should be used to illustrate the verbal material. Interactivity was found to be a crucial factor in multimedia learning. Practice with a test as simple as a multiple-choice test leads to a significant increase in learning. Therefore, it is also imperative that more stress should be laid on interactive practice opportunities.

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APPENDIX

A. PRE- & POSTTEST

B. LIST OF THE 50 L2 TARGET-WORDS

C. FRENCH VERSION OF THE STIMULUS TEXT

D. ENGLISH VERSION OF THE STIMULUS TEXT

E. EXAMPLES OF QUESTIONS IN THE INTERACTIVE TESTF1

F1. ANOVA: PRETEST SCORES

F2. CORRELATION TABLE

F3. ANOVA: INCREASE IN PERFORMANCE & POST HOC TEST

APPENDIX A - PRE/POSTTEST

FRENCH VOCABULARY ASSESSMENT

This multiple-choice test is to assess the amount and kind of vocabulary students in the different levels have integrated.
Results will be used in a final year project.
Please do your best to answer EACH of the 50 following questions, by circling the right number:

Réveiller
1-to feel sleepy
2-to fall asleep
3-to go to bed
4-to awaken

Book
1-la lèvre
2-le livre
3-le rêve
4-la louve

Sauter
1-to hinder
2-to avoid
3-to go out
4-to jump

Forest
1-la férocité
2-la feuille
3-la forêt
4-le fer

le pied
1-pedestrian
2-loss
3-foot
4-pain

Snake
1-le serpent
2-le persan
3-la serpe
4-le percement

le mouton
1-engine
2-break-down
3-sheep
4-screw

Drawing
1-le dessein
2-le tiroir
3-le dessert
4-le dessin

Rencontrer
1-to leave
2-to counter
3-to tell
4-to meet

To sleep
1-dormir
2-courir
3-réveiller
4-délirer

la peur
1-thirst
2-butter
3-fear
4-mouth

To think
1-renvoyer
2-comprendre
3-finir
4-réfléchir

le sourire
1-mouse
2-chest
3-shirt
4-smile

Pencil
1-le crayon
2-le stylo
3-la craie
4-la peine

Malade
1-sick
2-evil
3-dry
4-wrong

Hat
1-le château
2-la campagne
3-le chapeau
4-la hâte

le visage
1-gaze
2-vision
3-face
4-neck

Open
1-oublié
2-ombragé
3-ouvert
4-onéreux

Chez moi
1-at my place
2-in my possession
3-in my opinion
4-in my days

Closed
1-fini
2-fermé
3-farouche
4-effeuillé

la poche
1-wall
2-gate
3-pocket
4-peach

Painter
1-le plâtrier
2-le pâtissier
3-la pâture
4-le peintre

la tête
1-party
2-vice
3-head
4-tail

Tiresome
1-tirant
2-fatigant
3-fatigué
4-tiraillé

la foudre
1-thunder
2-hunger
3-fair
4-feast

Profession
1-le mensonge
2-la mésange
3-le métier
4-la métisse

l'avion
1-meat
2-wind
3-plane
4-bird

To fly
1-moucher
2-flâner
3-voler
4-planifier

l'herbe
1-spice
2-grass
3-bush
4-tree

World
1-la carte
2-la tombe
3-le monde
4-le miel

l'étoile
1-star
2-cloud
3-sky
4-weather

Tie
1-le tilleul
2-la cravate
3-la veste
4-la manche

Seul
1-old
2-dirty
3-loud
4-alone

Engine
1-l'engin
2-le moteur
3-l'engelure
4-la machine

la panne
1-pan
2-pain
3-breakdown
4-effort

Death
1-le meurtre
2-le mal
3-la moue
4-la mort

Boire
1-to swallow
2-to believe
3-to drink
4-to order

Sand
1-la saveur
2-le serveur
3-la fable
4-le sable

la terre
1-moon
2-distance
3-tree
4-region

Voice
1-le vice
2-le vert
3-la voix
4-l'avoine

la faim
1-woman
2-hunger
3-war
4-knee

Eyes
1-les oeufs
2-les yeux
3-les oeillets
4-les oies

l'eau
1-summer
2-ice
3-water
4-food

(Paper) Sheet
1-la feuille de papier
2-le stylo de papier
3-la case en papier
4-l'écriture sur papier

la caisse
1-bin
2-box
3-suitcase
4-drawer

Bad Mood
1-la mauvaise haleine
2-le mauvais esprit
3-la mauvaise pensée
4-la mauvaise humeur

Stupéfait
1-alone
2-astonished
3-stupid
4-stubborn

le bélier
1-ram
2-beauty
3-bell
4-inconvenience

Thirst
1-la sève
2-la soif
3-la soie
4-la faim

la corne
1-crown
2-horn
3-corn
4-bone

Age:

Sex: *M* *F*

- How long have you been learning/did you learn French for?

_____

THANKS A LOT
HAVE A NICE DAY!

APPENDIX B
-THE 50 L2 TARGET-WORDS WITH ENGLISH TRANSLATIONS

Concrete Nouns

l'avion	*plane*
le bélier	*ram*
la caisse	*box*
le chapeau	*hat*
la corne	*horn*
la cravate	*tie*
le crayon	*pencil*
le dessin	*drawing*
l'eau	*water*
l'étoile	*star*
la forêt	*forest*
la foudre	*thunder*
l'herbe	*grass*
le livre	*book*
le monde	*world*
le moteur	*engine*
le mouton	*sheep*
le peintre	*painter*
le pied	*foot*
la poche	*pocket*
le sable	*sand*
le serpent	*snake*
le sourire	*smile*
la terre	*earth/region*
la tête	*head*
le visage	*face*

Abstract Nouns

27. la faim	hunger
28. le métier	profession
29. la mort	death
30. la peur	fear
31. la soif	thirst
32. la voix	voice

Adjectives

33. fatigant	*tiresome*
34. fermé	*closed*
35. malade	*sick*
36. ouvert	*open*
37. seul	*alone*
38. stupéfait	*astonished*

Verbs

39. boire	*to drink*
40. dormir	*to sleep*
41. réfléchir	*to think*
42. rencontrer	*to meet*
43. réveiller	*to awaken*
44. sauter	*to jump*
45. voler	*to fly*

Others

46. chez moi	*at my place*
47. en panne	*broken-down*
48. feuille de papier	*sheet of paper*
49. frotter les yeux	*to rub one's eyes*
50. mauvaise humeur	*bad mood*

APPENDIX C - FIRST TWO CHAPTERS OF *LE PETIT PRINCE* BY DE SAINT-EXUPÉRY (1943)

I. Lorsque j'avais six ans j'ai vu, une fois, une magnifique image, dans un livre sur la Forêt Vierge qui s'appelait "Histoires Vécues". Ça représentait un serpent boa qui avalait un fauve. Voilà la copie du dessin.

On disait dans le livre: "Les serpents boas avalent leur proie toute entiére, sans la mâcher. Ensuite ils ne peuvent plus bouger et ils dorment pendant les six mois de leur digestion."

J'ai alors beaucoup réfléchi sur les avanetures de la jungle et, à mon tour, j'ai réussi, avec un crayon de couleur, à tracer mon premier dessin. Mon dessin numéro 1. Il était comme ça:

J'ai montré mon chef-d'oeuvre aux grandes personnes et je leur ai demandé si mon dessin leur faisait peur.

Elles m'ont répondu: "Pourquoi un chapeau ferait-il peur ?"

Mon dessin ne représentait pas un chapeau. Il représentait un serpent boa qui digérait un éléphant. J'ai alors dessiné l'intérieur du serpent boa, afin que les grandes personnes puissent comprendre. Elles ont toujours besoin d'explications. Mon dessin numero 2 était comme ça:

Les grandes personnes m'ont conseillé de laisser de côté les dessins de serpents boas ouverts ou fermés, et de m'intéresser plutôt à la géographie, à l'histoire, au calcul et à la grammaire. C'est ainsi que j'ai abandonné, à l'âge de six ans, une magnifique carrière de peintre. J'avais été découragé par l'insuccès de mon dessin numéro 1 et de mon dessin numéro 2. Les grandes personnes ne comprennent jamais rien toutes seules, et c'est fatigant, pour les enfants, de toujours et toujours leur donner des explications.

J'ai donc dû choisir un autre métier et j'ai appris à piloter des avions. J'ai volé un peu partout dans le monde. Et la géographie, c'est exact, m' a beaucoup servi. Je savais reconnaître, du premier coup d'oeil, la Chine de l'Arizona. C'est très utile, si l'on est égaré pendant la nuit.

J'ai ainsi eu, au cours de ma vie, des tas de contacts avec des tas de gens sérieux. J'ai beaucoup vécu chez les grandes personnes. Je les ai vues de très près. Ça n'a pas trop améliore mon opinion**.**

Quand j'en rencontrais une qui me paraissaît un peu lucide, je faisais l'expérience sur elle de mon dessin numéro 1 que j'ai toujours conservé. Je voulais savoir si elle était vraiment compréhensive. Mais toujours elle me répondait: "C'est un chapeau." Alors je ne lui parlais ni de serpents boas, ni de forêts vierges, ni d'étoiles. Je me mettais à sa portée. Je lui parlais de bridge, de golf, de politique et de cravates. Et la grande personne était bien contente de connaître un homme aussi raisonnable.

II. J'ai ainsi vécu seul, sans personne avec qui parler véritablement, jusqu' à une panne dans le désert du Sahara, il y a six ans. Quelque chose s'était cassé dans mon moteur. Et comme je n'avais avec moi ni mécanicien, ni passagers, je me préparai à essayer de réussir, tout seul, une réparation difficile. C'était pour moi une question de vie ou de mort. J'avais à peine de l'eau à boire pour huit jours.

Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'Océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait:

-- S'il vous plaît... dessine-moi un mouton !

-- Hein !

-- Dessine-moi un mouton...

J'ai sauté sur mes pieds comme si j'avais été frappé par la foudre. J'ai bien frotté mes yeux. J'ai bien regardé. Et j'ai vu un petit bonhomme tout à fait extraordinaire qui me considérait gravement. Voilà le meilleur portrait que, plus tard, j'ai réussi à faire de lui. Mais mon dessin, bien sûr, est beaucoup moins ravissant que le modèle. Ce n'est pas ma faute. J'avais été découragé dans ma carrière de peintre par les grandes personnes, à l'âge de six ans, et je n'avais rien appris à dessiner, sauf les boas fermés et les boas ouverts.

Je regardai donc cette apparition avec des yeux tout ronds d'étonnement. N'oubliez pas que je me trouvais à mille milles de toute région habitée. Or mon petit bonhomme ne me semblait ni égaré, ni mort de fatigue, ni mort de faim, ni mort de soif, ni mort de peur. Il n'avait en rien l'apparence d'un enfant perdu au milieu du désert, à mille milles de toute région habitée. Quuand je reussis enfin a parler, je lui dis:

-- Mais... qu'est-ce que tu fais là ?

Et il me répéta alors, tout doucement, comme une chose très sérieuse:

--S'il vous plaît... dessine-moi un mouton...

Quand le mystère est trop impressionnant, on n'ose pas désobeir. Aussi absurde que cela me semblât à mille milles de tous les endroits habités et en danger de mort, je sortis de ma poche une feuille de papier et un stylographe. Mais je me rappelai alors que j'avais surtout étudié la géographie, l'histoire, le calcul et la grammaire et je dis au petit bonhomme (avec un peu de mauvaise humeur) que je ne savais pas dessiner. Il me repondit:

-- Ça ne fait rien. Dessine-moi un mouton.

Comme je n'avais jamais dessiné un mouton je refis, pour lui, I'un des deux seuls dessins dont j'étais capable. Celui du boa fermé. Et je fus stupéfait d'entendre le petit bonhomme me repondre:

-- Non ! Non ! Je ne veux pas d'un éléphant dans un boa. Un boa c'est très dangereux, et un éléphant c'est très encombrant. Chez moi c'est tout petit. J'ai besoin d'un mouton. Dessine-moi un mouton.

Alors j'ai dessiné.

Il regarda attentivement, puis:

-- Non ! Celui-là est déjà très malade. Fais-en un autre.

Je dessinai:

Mon ami sourit gentiment, avec indulgence:

--Tu vois bien... ce n'est pas un mouton, c'est un bélier. Il a des cornes...

Je refis donc encore mon dessin:

Mais il fut refusé, comme les précédents:

-- Celui-là est trop vieux. Je veux un mouton qui vive longtemps.

Alors, faute de patience, comme j'avais hâte de commencer le démontage de mon moteur, je griffonnai ce dessin-ci.

Et je lançai:

-- Ça c'est la caisse. Le mouton que tu veux est dedans.

Mais je fus bien surpris de voir s'illuminer le visage de mon jeune juge:

-- C'est tout à fait comme ça que je le voulais! Crois-tu qu'il faille beaucoup d'herbe à ce mouton ?

-- Pourquoi ?

-- Parce que chez moi c'est tout petit...

-- Ça suffira sûrement. Je t'ai donné un tout petit mouton.

Il pencha la tête vers le dessin:

--Pas si petit que ça... Tiens ! Il s'est endormi...

Et c'est ainsi que je fis la connaissance du petit prince.

APPENDIX D - FIRST TWO CHAPTERS OF *LE PETIT PRINCE* TRANSLATED INTO ENGLISH (WOODS, 1945; FNE, 1997)

I. Once when I was six years old I saw a magnificent picture in a book, called "True Stories", about the primeval forest. I was a picture of a boa constrictor in the act of swallowing an animal. Here is a copy of the drawing.

In the book it said: "Boa constrictors swallow their prey whole, without chewing it. After that, they are not able to move, and they sleep through the six months that they need for digestion."

I pondered deeply, then, over the adventures of the jungle. And after some work with a coloured pencil I succeeded in making my first drawing, My drawing number 1 looked like this.

I showed my masterpiece to the grown-ups, and asked them whether the drawing frightened them.

But they answered: "Frighten? Why should any one be frightened by a hat?"

My drawing was not a picture of a hat. It was a picture of a boa constrictor digesting an elephant. But since the grown-ups were not able to understand it, I made another drawing: I drew the inside of the boa constrictor so that the grown-ups could see it clearly. They always need to have things explained. My drawing number 2 looked like this:

The grown-ups' response, this time, was to advise me to lay aside my drawings of boa constrictors, whether from the inside or the outside, and devote myself instead to geography, history, arithmetic and grammar. That is why, at the age of six, I gave up what might have been a magnificent career as a painter. I had been disheartened by the failure of my drawing number 1 and my drawing number 2. Grown-ups never understand anything by themselves, and it is tiresome for children to be always and forever explaining things to them.

So then I chose another profession, and learned to pilot aeroplanes. I have flown a little over all parts of the world; and it is true that geography has been very useful to me. At a glance I can distinguish China from Arizona. If one gets lost in the night, such knowledge is valuable.

In the course of this life I have had a loads of encounters with loads of serious people. I have lived a great deal among grown-ups. I have seen them intimately, close at hand. And that hasn't much improved my opinion of them.

Whenever I met one of them who seemed to me at all clear-sighted, I tried the experiment of showing him my drawing number 1, which I have always kept. I would try to find out, so, if this was a person of true understanding. But, whoever it was, he, or she, would always say:

"That is a hat"

Then I would never talk to that person about boa constrictors, or primeval forests, or stars. I would bring myself down to his level. I would talk to him about bridge, and golf, and politics, and neckties. And the grown-up would be greatly pleased to have met such a sensible man.

So I lived my life alone, without anyone that I could really talk to, until I had an accident with my plane in the Desert of Sahara, six years ago. Something was broken in my engine. And as I had with me neither mechanic nor any passengers, I set myself to attempt the difficult repairs all alone. It was a question of life or death for me: I had scarcely enough drinking water to last a week.

The first night, then, I went to sleep on the sand, a thousand miles from any human habitation. I was more isolated than a shipwrecked sailor on a raft in the middle of the ocean Thus you can imagine my amazement, at sunrise, when I was awakened by an odd little voice. It said:

"If you please--draw me a sheep!"

"What!"

I jumped to my feet, completely thunderstruck. I blinked my eyes hard. I looked carefully all around me. And I saw a most extraordinary small person, who stood there examining me with great seriousness. Here you may see the best por-

trait that, later, I was able to make of him. But my drawing is certainly very much less charming than its model.

That, however, is not my fault. The grown-ups discouraged me in my painter's career when I was six years old, and I never learned to draw anything, except boas from the outside and boas from the inside.

Now I stared at this sudden apparition with my eyes fairly starting out of my head in astonishment. Remember, I had crashed in the desert a thousand miles from any inhabited region. And yet my little man seemed neither to be straying uncertainly among the sands, nor to be fainting from fatigue or hunger or thirst or fear. Nothing about him gave any suggestion of a child lost in the middle of the desert, a thousand miles from any human habitation. When at last I was able to speak, I said to him:

"But--what are you doing here?"

And in answer he repeated, very slowly, as if he were speaking of a matter of great consequence:

"If you please--draw me a sheep . . ."

When a mystery is too overpowering, one dare not disobey. Absurd as it might seem to me, a thousand miles from any human habitation and in danger of death, I took out of my pocket a sheet of paper and my fountain-pen. But then I remembered how my studies had been concentrated on geography, history, arithmetic and grammar, and I told the little chap (a little crossly, too) that I did not know how to draw. He answered me:

"That doesn't matter. Draw me a sheep"

But I had never drawn a sheep. So I drew for him one of the two pictures I had drawn so often. It was that of the boa constrictor from the outside. And I was astounded to hear the little fellow greet it with,

"No, no, no! I do not want an elephant inside a boa constrictor. A boa constrictor is a very dangerous creature, and an elephant is very cumbersome. Where I live, everything is very small. What I need is a sheep. Draw me a sheep."

So then I made a drawing.

He looked at it carefully, then he said:

" No. This sheep is already very sickly. Make me another."

So I made another drawing.

My friend smiled gently and indulgently.

"You see yourself," he said, "that this is not a sheep. This is a ram. It has horns."

So then I did my drawing over once more. But it was rejected too, just like the others.

" This one is too old. I want a sheep that will live a long time."

By this time my patience was exhausted, because I was in a hurry to start taking my engine apart. So I tossed off this drawing. And I threw out an explanation with it.

"This is only his box. The sheep you asked for is inside."

I was very surprised to see a light break over the face of my young judge: "That is exactly the way I wanted it! Do you think that this sheep will have to have a great deal of grass?"

"Why?"

"Because where I live everything is very small . . . "

"There will surely be enough grass for him," I said. "It is a very small sheep that I have given you."

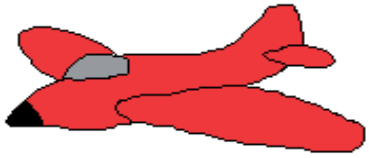
He bent his head over the drawing:

"Not so small that -- Look ! He has gone to sleep . . ."

And that is how I made the acquaintance of the little prince.

APPENDIX E
- EXAMPLES OF QUESTIONS IN THE INTERACTIVE PRACTICE TEST

Choose the word that matches the picture



1 l'oiseau
2 l'avion
3 l'aviron

1 le vivant
2 la mort
3 le meurtre

Please Make Your Selection

L2-L1:	la caisse	1 cash 2 box 3 break
L1-L2:	grass	1 la graisse 2 le gosier 3 l'herbe

Choose the word(s) that fit(s) the blank(s)

"Je suis _____ et j'aimerais _____quelqu'un"

1 sale -- contrefaire
2 seul -- rencontrer
3 las -- remercier

"Quand on est _____, il faut beaucoup _____."

1 mechant -- croire
2 malade -- boire
3 malheureux -- se frotter les yeux

APPENDIX F
- RAW DATA

				Errors			Errors			
Condition	*Age*	*Sex*	**Pretest**	L1L2	L2L1	**Posttest**	L1L2	L2L1	*Diff*	**Increase**
control	20	male	21	12	17	28	11	11	7	**33.33**
control	22	female	45	2	3	46	3	1	1	**2.22**
control	30	male	41	4	5	42	3	5	1	**2.44**
control	29	male	43	2	5	43	1	6	0	**0.00**
control	22	female	32	7	11	34	6	10	2	**6.25**
control	21	female	32	8	10	39	5	6	7	**21.88**
control	21	female	40	5	5	45	3	2	5	**12.50**
control	22	male	39	3	8	49	1	0	10	**25.64**
control	22	male	32	6	12	38	5	7	6	**18.75**
imagery	23	male	25	12	13	30	9	11	5	**20.00**
imagery	33	female	44	1	5	46	2	2	2	**4.55**
imagery	34	male	39	6	5	43	4	3	4	**10.26**
imagery	30	female	12	16	22	20	12	18	8	**66.67**
imagery	20	male	46	1	3	49	0	1	3	**6.52**
imagery	19	female	29	6	15	39	4	7	10	**34.48**
imagery	23	female	26	13	11	32	9	9	6	**23.08**
imagery	28	female	20	14	16	25	12	13	5	**25.00**
imagery	25	male	37	3	10	44	3	3	7	**18.92**
imagery	35	male	37	5	8	38	4	8	1	**2.70**
imagery	74	male	24	11	15	33	7	10	9	**37.50**
imagery	22	female	24	10	16	30	9	11	6	**25.00**
interact	22	female	19	13	18	33	8	9	14	**73.68**
interact	32	male	27	12	11	42	4	4	15	**55.56**
interact	21	female	42	3	5	48	1	1	6	**14.29**
interact	30	male	22	12	16	31	9	10	9	**40.91**
interact	24	female	35	6	9	47	3	0	12	**34.29**
interact	22	male	32	7	11	47	0	3	15	**46.88**
interact	23	male	42	1	7	47	1	2	5	**11.90**
interact	22	male	40	2	8	42	3	5	2	**5.00**
interact	22	female	41	5	4	48	0	2	7	**17.07**
interact	28	male	34	11	5	43	3	4	9	**26.47**
im&int	31	male	37	5	8	45	2	3	8	**21.62**
im&int	32	male	33	10	7	46	3	1	13	**39.39**
im&int	34	female	37	5	8	47	1	2	10	**27.03**
im&int	45	female	33	7	10	47	2	1	14	**42.42**
im&int	45	female	22	13	15	27	6	17	5	**22.73**
im&int	29	female	25	12	13	44	2	4	19	**76.00**
im&int	30	female	34	5	11	43	3	4	9	**26.47**
im&int	33	female	39	4	7	48	0	2	9	**23.08**
im&int	25	male	28	11	11	38	7	5	10	**35.71**
im&int	32	male	32	6	12	43	2	5	11	**34.38**

APPENDIX G1
- ANOVA ON PRETEST MEANS

- - - - - O N E W A Y - - - - -

Variable PRETEST
By Variable COND condition

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	3	186.5099	62.1700	.9115	.4448
Within Groups	37	2523.5389	68.2038		
Total	40	2710.0488			

Levene Test for Homogeneity of Variances

Statistic	df1	df2	2-tail Sig.
2.0120	3	37	.129

- - - - - O N E W A Y - - - - -

Variable PRETEST
By Variable COND condition

Multiple Range Tests: LSD test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= 5.8397 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE: 2.87

- No two groups are significantly different at the .050 level

APPENDIX G2
- CORRELATION TABLE

- - Correlation Coefficients - -

	AGE	DIFF	INCR	POSTEST1	PRETEST	SEX
AGE	1.0000	.1268	.1442	-.1250	-.1824	-.0941
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .	P= .430	P= .368	P= .436	P= .254	P= .558
DIFF	.1268	1.0000	.8769	.1284	-.4176	.0812
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .430	P= .	P= .000	P= .424	P= .007	P= .614
INCR	.1442	.8769	1.0000	-.2697	-.7164	.1467
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .368	P= .000	P= .	P= .088	P= .000	P= .360
POSTEST1	-.1250	.1284	-.2697	1.0000	.8475	-.1074
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .436	P= .424	P= .088	P= .	P= .000	P= .504
PRETEST	-.1824	-.4176	-.7164	.8475	1.0000	-.1418
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .254	P= .007	P= .000	P= .000	P= .	P= .376
SEX	-.0941	.0812	.1467	-.1074	-.1418	1.0000
	(41)	(41)	(41)	(41)	(41)	(41)
	P= .558	P= .614	P= .360	P= .504	P= .376	P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

APPENDIX G3 - ANOVA
INCREASE IN PERFORMANCE AS A FUNCTION OF MULTIMEDIA SET-UP

- - - - - O N E W A Y - - - - -

Variable INCR
By Variable COND condition

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	3	2709.0787	903.0262	2.9696	.0442
Within Groups	37	11251.3554	304.0907		
Total	40	13960.4342			

Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean
Grp 1	9	13.6678	11.8510	3.9503	4.5584 TO 22.7773
Grp 2	12	22.8893	17.7582	5.1263	11.6063 TO 34.1723
Grp 3	10	32.6044	21.8445	6.9078	16.9778 TO 48.2310
Grp 4	10	34.8831	16.2079	5.1254	23.2886 TO 46.4775
Total	41	26.1599	18.6818	2.9176	20.2632 TO 32.0566

Levene Test for Homogeneity of Variances

Statistic	df1	df2	2-tail Sig.
1.0193	3	37	.395

- - - - - O N E W A Y - - - - -

Variable INCR
By Variable COND condition

Multiple Range Tests: LSD test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= 12.3307 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE: 2.87

(*) Indicates significant differences which are shown in the lower triangle

Mean	COND	G r p 1	G r p 2	G r p 3	G r p 4
		1	2	3	4
13.6678	Grp 1				
22.8893	Grp 2				
32.6044	Grp 3	*			
34.8831	Grp 4	*			

Tables & Figures

I . Tables

Tables 3.1 Mean Pretest and Posttest Scores

Tables 3.2 Men Increase in Performance

Tables 3.3 Proportions of Errors Following the Intractive Test

II . Figures

Figures 1.1 First of the *Model Millionaire* (Symbol, 1996)

Figures 1.2.1 Verbal and Nonverbal Symbolic Systems (Paivio, 1986)

Figures 1.2.2 Bilingual Version of Dual Coding Memory (Paivio & Desrochers, 1980)

Figures 2.3.1 New Screen Layout: Example of Illustrated Text

Figures 2.3.2 New Screen Layout: Example of an *Image* Question Type in the interactive Test

Figures 3.1 Mean Pretest and Postest Scores

Figures 3.2 Mean Increase in Performance

Figures 3.3 Proportions of Errors in Terms of Direction