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AUTOMATICITY AND LEXICAL SKILLS IN SECOND LANGUAGE FLUENCY: IMPLICATIONS FOR COMPUTER ASSISTED LANGUAGE LEARNING

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Abstract: *This article addresses the question of how computer assisted language learning should be designed to promote second language lexical fluency. The discussion reviews findings in the psychological literature concerning the nature of lexical development, transfer appropriate learning, the conditions that promote automaticity in skilled performance, and ways to assess level of automaticity. The paper outlines a possible application of computer assisted language learning to lexical skill development that takes into account the psychological issues reviewed.*

1. Introduction: How can we best promote fluency of lexical skills in a second language? In this paper we address this question by considering the following issues. First, where do lexical skills come from? Second, what is the role of automaticity in fluency and what conditions promote automaticity in lexical skill development? And finally, given what we know about the acquisition of lexical skills and the development of automaticity, what are the implications for computer assisted language learning? We illustrate our answer to this last question with a hypothetical example of a computer assisted language learning activity that reflects our consideration of automaticity in lexical development and we suggest how one might assess the impact of this activity on automaticity.

Lexical skills are among the most fundamental components of first language reading and listening comprehension. In part this is true, of course, for the obvious reason that one has to handle and understand a great many words - most literate adults know many tens of thousands of words, and some people know well over a hundred thousand words - in order to understand the normal speech and text one encounters every day. However, the centrality of vocabulary to language functioning goes well beyond familiarity with words. Most of what we hear and read requires more than simply understanding individual words in isolation; information must be integrated across the text or spoken discourse, and it must interact with our general knowledge. It must also be processed along many different dimensions, including syntactic, pragmatic and sociolinguistic considerations. Thus, we can expect that any measure of general reading comprehension ability reflecting all these considerations will differ from a measure of simple vocabulary knowledge in important ways.

Despite the obvious differences between reading comprehension and lexical knowledge, it is nevertheless true that measures of lexical skill still remain among the best predictors of reading comprehension level (Sternberg, 1987). It is reasonable to suppose, then, that the acquisition of lexical skill entails the acquisition of other skills that are central to reading and language comprehension, skills that go beyond simple association of dictionary like meanings to words. This idea is reinforced by the additional finding that lexical skill is also probably the best single predictor of performance on intelligence tests (Sternberg, 1987). Thus it would seem that lexical skill reflects something quite central to language-based cognitive functioning far beyond what is required in terms of simple word knowledge. Determining what this something else is will be important to our understanding of how to promote lexical development (see McKeown & Curtis, 1987). As we will see, the factors that underlie this centrality of (first language) vocabulary skills for general language ability will also have important implications for our understanding of how fluency is attained in a second language and for how fluency can be trained.

The focus of this paper is fluency of lexical skills in a second language. The term *lexical skill* itself covers a broad territory, and as Kameenui, Dixon and Carnine (1987) point out, there are many dimensions to vocabulary knowledge, all of which should be taken into account in any consideration of instructional methods. For example, distinctions can be made regarding receptive versus expressive vocabulary knowledge, and among full concept

knowledge, partial concept knowledge and verbal association (simple pairing of labels with meanings), and in its largest sense, fluency may be thought to include all these considerations (also, see Schmidt, 1992, for an extensive discussion of issues involved here). Important as these distinctions are, however, in this paper we will be concerned with fluency as understood in a relatively narrow sense - namely, in terms of speed and ease of word recognition and recall. As we will see below, this allows for a convenient operational definition enabling us to address significant issues underlying fluency of lexical skill.

2. Lexical Skills: In this section we draw attention to two important points. First, lexical skills are best developed in context, not through specific vocabulary instruction. Second, for learning to be effective, the contextual conditions should respect what theorists of memory and learning refer to as transfer appropriate learning.

2.1. Vocabulary develops in context. Fundamental to this discussion is the idea that in one's first language most vocabulary skills are developed in context, not from specific lexical instruction (Nagy & Herman, 1987; Sternberg, 1987). There are several reasons for believing this to be true. First, as Nagy and Herman (1987) have calculated, vocabulary skills increase at a rate that is simply too great to be accounted for by formal, explicit training experiences; most of the vocabulary must therefore be learned from incidental language experiences (general reading, speech of others, media, etc.). They estimate that during the school years English speakers typically increase their vocabulary by about 3000 words per year and finally attain fluent lexical skill with 40,000 or more words.

Nagy and Herman (1987) argue further that knowledge - including vocabulary knowledge - is *schema* organized. This means that knowing where a piece of information fits in one's larger body of knowledge is a critical part of what it means to understand it. It has been argued that learning words through definitions and associations with synonyms is not very effective (e.g., Anderson & Freebody, 1983). Rather, background information and knowledge of the subject material is crucial to comprehension. For example, studies reported in Bransford and Johnson (1973), in which virtually incomprehensible texts were made comprehensible with an appropriate title or accompanying picture, are instructive in this regard. As stated by Nagy and Herman (1987, p.30), 'word learning cannot be equated with memorizing synonyms or short definitions. Rather, words must be treated as labels for concepts that are embedded in larger schemata. Instruction must aim at establishing rich ties between new words and prior knowledge and must present new words and concepts in the context of larger domains of knowledge'.

Sternberg (1987) provides interesting support for this idea. He reports a study in which subjects in the experimental conditions received various types of training in the use of contextual information to understand the meaning of new words. Control group subjects either received practice without context training or with simple vocabulary-memorization training. The data clearly indicated that training involving the use of contexts resulted in superior learning of new words.

Overall, this literature supports the view that lexical skills (in the first language) are developed not so much through explicit vocabulary instruction as through encounters with new items in a variety of contexts that provide support for learning. This enables the learner to embed the new meanings in the general cognitive structures or knowledge she or he has about the language. This conclusion dovetails in an important way with another fundamental idea in psychology: the importance of transfer appropriate learning for memory retrieval.

2.2. Transfer appropriate learning facilitates memory retrieval. Transfer appropriate learning refers to the idea that later memory retrieval will be successful to the extent that the encoding processes that were active at the time of study are re-activated at the time of retrieval (Blaxton, 1989; Morris, Bransford & Franks, 1977; Roediger, 1990; Tulving, 1983). This idea is based on the view that when we learn some information - say, the meaning of a word - we encode with it a record of the perceptual and other processes that were active at the time of learning. Subsequent retrieval of the target word information involves re-activating that record of processes; the greater the extent of the match between processes active at the time of learning and those re-activated at the time of retrieval, the greater the success of recollection.

The requirement for a match between processing activities at the time of learning and retrieval is related to the idea of encoding specificity (Tulving & Thomson, 1973; Tulving, 1983), an idea that has had profound implications for our understanding of memory. As

Tulving (1983) has pointed out, the principle of encoding specificity means that we must not simply ask questions about memory that address learning conditions and memory test conditions in isolation. There is no ideal learning condition that we can hope to specify without making reference to the conditions under which that learning will have to be demonstrated; nor can we specify some ideal testing condition without due regard for how the information or skill to be tested was first learned. There is always a need for joint consideration of learning and retrieval conditions. Now, if learning at one time, say in the classroom, is to be transferred to later occurring situations outside the classroom, then we must know something about the psychological processing demands in that later time so that we can arrange for learning to be appropriate for the purposes of transfer.

One implication of this idea is that it provides an alternative way of understanding what happens in studies purporting to show superior memory for information processed for its meaning in what is known as a levels, or depth, of processing effect. A levels of processing effect occurs when subjects show better memory for information that was originally processed to a deep semantic level as opposed to nonsemantically (Craik & Lockhart, 1972) or to a shallow semantic level (e.g., Hashtroudi, 1983). Proponents of the levels of processing approach have claimed that memory representations of semantically processed information are inherently more stable or otherwise better consolidated than nonsemantically processed information. Morris *et al* (1977) showed, however, that the operative factor in memory is not the semantic nature of the processing but the match in processing between learning and test. Of course, unless otherwise instructed, we do in fact normally engage in semantic processing when we try to recall previously learned information, because normally words are used semantically when we communicate. It follows from this, then, that the most transfer appropriate strategy for learners will normally be one involving semantic processing at the time of acquisition, and that is why we see depth of processing effects so readily.

What, then, are the implications for the student's ability to retrieve vocabulary in the real world? First, we must recognize that retrieval is essentially a reconstructive search process. The richer and more varied the informational linkages leading to the target information - say, a particular vocabulary item or a meaning representation - the greater the chances of fast and accurate retrieval of that information. The relevant linkages are those that have been established in the past, especially at the time of learning. However, to be useful, those linkages must be activated at the time of retrieval; the mere existence of a wide network of linkages will not, by itself, guarantee quick and successful retrieval unless the person actually activates them. That is why to enhance the probability of retrieving information when it is needed, one needs to ensure that it is encoded at the time of learning in a manner appropriate to the retrieval circumstances that will be encountered later.

The second point is that the fluency of retrieval - its speed and ease - will reflect the directness of the search. If the search involves 'false leads', too much decision making, or other time consuming activities, then the fluency of the retrieval act will be compromised and will appear to observers and feel to the retriever as though a great deal of effort is involved (see also Nation, 1993).

In summary, we see that lexical skills are best developed when vocabulary is learned in context, in circumstances that make possible linking the new information to prior knowledge and to do so in a varied and rich way. This accomplishes much more than creating a multiplicity of retrieval routes. Given the likelihood that at the time of later access the person will again activate a process of updating and searching through complex knowledge representations (since most communication requires this), learning in context promotes transfer appropriate encoding processes. In the case of second language lexical skills the implications are straightforward. One should learn the new vocabulary, as far as is possible, in a context that places the same demands on the learner as one normally finds in genuine communication. This would include demands to make associations across meanings, to search through already acquired knowledge, to make use of supportive contextual cues, to handle distracting contextual cues, etc. We will return to this idea later in our discussion of how computer assisted language learning programs may be adapted to reflect the demands of transfer appropriate learning.

3. Automaticity and Fluency: We now turn to the topic of automaticity and consider the following two points. First, automaticity of lexical processing is central to language fluency. Second, automaticity can be understood as the economical restructuring of underlying processing mechanisms. We conclude this part of the discussion with consideration of some of the ways to

operationalize automaticity so that it can be measured in various situations.

3.1. Automaticity is a central aspect of fluency. Central to virtually all discussions about fluency is the issue of automaticity. Shortly, we will make clearer in operational terms what is meant by automaticity, but for the moment it is sufficient to understand the term in its more general sense as referring to those aspects of performance that, as a result of extensive practice, become faster, more reliable and which seem to the performer (and perhaps to observers) to have become relatively effortless. Fluency in general, of course, involves more than just automaticity. There are questions of accuracy and appropriateness as well (including, for example, consideration of sociolinguistic competence). However, automaticity is clearly a major aspect of what people normally understand fluency to involve (e.g., in the Webster's Third New International Dictionary (1976, p.876) definitions of *fluency* and *fluent*, the ideas of ease, readiness, and smoothness of performance are recurrent; see also, Nation, 1993, p. 121).

Why is it beneficial for one's overall performance to automatize some aspects of the underlying skill? Theorists have generally answered this question in one of two ways, each reflecting different views about what happens when a process becomes automatic. The first approach, reflecting the view that automaticity essentially involves a reduction in the consumption of attentional resources, holds that the more performance is automatized - that is, becomes effortless - the greater the amount of processing resources released for other aspects of the activity. Thus, if word recognition is automatic then the language user will have more attentional resources available to focus on the integration of information, the planning of future utterances, the processing of sociolinguistic and paralinguistic cues, etc. (Perfetti, 1985; Segalowitz, 1986; Segalowitz, Poulsen & Komoda, 1991). The second approach, which is logically independent of the first, reflects the view that automaticity essentially involves freeing one component process from the influence of other processes - that is, when a given component of performance becomes automatized it becomes modularized (Fodor, 1983). The result is that this aspect of performance is carried out more accurately and efficiently, since there is no interruption or interference from other component processes (Segalowitz *et al*, 1991; Stanovich, 1991).

Evidence for the important role that automaticity of lexical skill plays in language fluency comes from several sources. In one study, Graesser, Hoffman and Clark (1980) had fast and slow readers read texts one sentence at a time in a design that permitted one to measure the time subjects looked at each sentence. The sentences were calibrated for various characteristics, such as the mean frequency in English of the words in the sentence, the level of syntactic complexity of the sentence, the degree of connectedness of the sentence to other sentences, the degree of narrative as opposed to expository qualities of the sentence, and so on. These characteristics could be grouped according to the level of cognitive processing they are associated with. For example, word frequency is a characteristic that would be expected to affect primary word recognition whereas the connectedness of each sentence to other sentences would be expected to affect integration of information across the text as a whole. By means of multiple regression analyses, the authors were able to assess the importance of each of these sentence characteristics to the determination of the time subjects looked at a given sentence. More specifically, they were able to assess the relative contributions to reading time of those characteristics associated with low level local processing of sentence information (e.g., word recognition) and those associated with higher level global processing (e.g., integration of information across sentences and text). Their principal finding is very important for the issues under consideration here. While higher level processing was found to be an important determinant for overall reading time, it did not distinguish between fast and slow readers. Rather, significant differences were found between the fast and slow readers on indices associated with low level processing. These results support the idea that fluency of lexical skills is central to the level of achievement in a complex language activity such as reading a text.

Segalowitz *et al* (1991) reported a similar investigation involving first and second language readers of English. The findings of this study also supported the conclusion just reported; it was at the level of local - rather than global - processing that the less fluent second language readers were distinguished from the more fluent first language readers. Thus, what appears to characterize fast (highly fluent) reading, is the rapidity of skill for dealing with information at the level of words. The level of skills involved in integrating information contained in the already understood words across the text or with general knowledge is less important in determining overall fluency. This suggests that second language training aimed at improving fluency should focus on the automatization of lexical skills.

In what may be considered a more direct study of automaticity in second language vocabulary skill, Favreau and Segalowitz (1983) found that highly fluent readers of a second language demonstrated more highly automatic word recognition skill, but not more highly developed control processes when compared to less fluent readers. This work was built on Posner and Snyder's (1975) distinction between automatic and controlled processes, and used an adaptation of Neely's (1977) primed lexical decision task paradigm. This task enables the experimenter to dissociate response times that are chiefly determined by the subject's conscious expectations (controlled processing) from those determined by automatic influences of one word upon another (automatic processing). The Favreau and Segalowitz (1983) adaptation of Neely's paradigm compared second language word recognition in two groups of highly skilled bilinguals - those who normally read their first and second languages at the same speed to achieve equally high levels of comprehension versus those who read their second language more slowly to achieve equally high levels of comprehension. They found that while the two groups were equally automatic in word recognition in their first language, the more highly fluent equal reading rate group was more automatic in second language word recognition than the unequal reading rate group. Thus, a lower level of automaticity was associated with slower reading performance. Moreover, examination of the subjects' language learning history showed that the equal reading group had received many more years of consistent second language exposure in their primary and secondary schooling than had the unequal reading rate group.

These studies address the fact that highly skilled users of language have a more highly developed degree of automaticity in their lexical skills than do less skilled users. Nation (1993) points out an important role such automaticity might play in the process of vocabulary development. With knowledge of the most frequent 2000 words of English plus 800 less frequent words of academic relevance (e.g., *assume, individual*), a student will have about 95% coverage of most words encountered in written material. This 95% coverage appears to be quite important for one's ability to handle material containing unknown items. For example, Nation reports earlier work in which students with 95% coverage were more skilled at guessing unknown items in a text than students with only 90% coverage. However, as Nation points out, knowledge of vocabulary is not sufficient by itself; the learner must have *fluency of access* for this basic vocabulary to be useful [a similar point is made by Meara (1993) and by Mezynski (1983)]. It is this combination of critical vocabulary size and a threshold level of fluency (speed and ease of access) that equips the learner to then expand her or his second language vocabulary through experience.

3.2. *Automaticity reflects the economical restructuring of underlying processes.* Earlier we defined automaticity very generally in terms of speed and ease of performance. If we wish to develop an operational definition that enables us to measure automaticity, we will have to be more precise. A review of the literature will quickly reveal, however, that there is no single, universally agreed upon operational definition of automaticity (Carr, 1992). Initially, researchers identified a number of characteristics thought to be true of any automatized aspect of skilled performance, and the automaticity of processes was treated as bi-valued; a process was either automatized or it was not. For example, Posner and Snyder (1975) originally proposed a dual process theory of skill which distinguished automatic processes that are fast, effortless and inhibitionless from controlled processes that are slow, effortful and involve inhibition. Other authors subsequently emphasized other characteristics; automatic processes were held to be ballistic or unstoppable, uninfluenced by intentions or strategies, and able to proceed without conscious awareness (see Carr, 1992, for an useful review of this topic in relation to automaticity of word recognition). Logan (Logan & Etherton, 1994) makes the important point that this property 'checklist' approach to automaticity misses the issue of what is the underlying mechanism involved. What unites these views is the idea that automatic processing does not reduce simply to faster or otherwise quantitatively improved information processing. Rather, when performance has become relatively more automatized, the manner by which the underlying mechanisms operate changes, and these changes reflect restructuring (Carr, 1992; Cheng, 1985; Logan & Etherton, 1994; Segalowitz & Segalowitz, 1993; see also Carr, 1992, for an interesting review of the neuropsychological research on the automatizing effects of practice on skill that supports this view).

The important conclusion here is that extensive practice leads to improved performance - fluency - through some kind of restructuring of the underlying processes. This restructuring will involve fewer, and more informationally encapsulated mechanisms than was the case prior to practice, and hence responses become faster and less influenced by other ongoing activities. This 'streamlining' of the complex mechanisms underlying performance has to be distinguished from improvements that simply reflect faster processing (Segalowitz, 1991), an issue discussed in the next section.

3.3. *Automatization can be operationally distinguished from speed-up.* The view of automatization as the streamlined restructuring of underlying processes makes possible an interesting and practical way to operationalize automaticity (Segalowitz & Segalowitz, 1993; Segalowitz, Watson & Segalowitz, in press). According to this view, one's level of automaticity in lexical skill reflects the nature of the blend of underlying processing components (see also, Jacoby, 1991). In one case, this blend might be characterized as involving relatively many slow, controlled, decision making processes and relatively few fast, encapsulated, highly efficient processes. In another case, say after appropriate training, the blend might shift through restructuring toward a reduction of reliance on the slower controlled processes with increased reliance on the faster, encapsulated processes. This will have the effect of decreasing overall processing time, enhancing ease of processing and, what is important here, decreasing variability in processing time (the standard deviation of RT) to a degree that is more than proportional to the reduction in the response time itself. When this happens, it indicates that practice has not simply resulted in a general speed up without restructuring, but rather that practice has produced a qualitative change in the way the skill is carried out (see Segalowitz & Segalowitz, 1993, for a more detailed discussion of this idea). Thus analysis of response time variability in a variety of settings, including single case studies, can reveal measurable changes in the fluency of lexical skill (Segalowitz *et al*, in press). This technique promises to be useful in assessing the impact of a given learning activity - including computer assisted learning - on the acquisition of fluency (automatization) of lexical skills.

4. Promoting Fluency: Here we address the question of what conditions are required for practice to lead to automaticity. This discussion will prepare the way for the next section which discusses the implications all this might have for computer assisted lexical skill development.

4.1. Consistent practice promotes automaticity. It is well known that extensive practice can improve performance through automatization. Here, no doubt, is where computer assisted language learning can be exploited for promoting automaticity of second language lexical skills. We need to inquire, then, under what conditions practice leads to automaticity.

Part of the answer to this question comes from the important work of Shiffrin and Schneider (e.g., Shiffrin & Schneider, 1977; Schneider & Shiffrin, 1977; Schneider & Fisk, 1982). They operationally defined automaticity in terms of performance that comes to be free of the influence of processing load, for example, when processing four stimuli no longer takes longer than processing two. They found that automatic performance, so defined, was obtained with training where stimulus-response associations were consistent rather than allowed to vary. For example, they successfully automatized performance in a memory task in which certain stimuli were always presented as targets and never as foils, whereas when a given set of stimuli served both as targets on some trials and as foils on others, performance was not automatized. The important conclusion to draw from their research is that repetition with consistent mapping of stimuli to responses leads to automaticity.

4.2. Learning is best under conditions of genuine communication. Another part of the answer comes from a major pedagogical insight of recent decades about second language learning, namely that learning is best when the student is engaged in genuine communication. Rote repetition, artificial role playing whose true social goal is to please the teacher, and other forms of non-natural ways of using language do not, in the long run, work very effectively; this has given rise to communicative approaches to language training (Canale & Swain, 1980). The criteria for establishing a truly communicative language learning situation are discussed at length in Gatbonton and Segalowitz (1988), together with an analysis of the psychological underpinnings that may be responsible for the tremendous success of the approach. The basic

idea of that analysis is that learning under conditions of genuine communication is an example of transfer appropriate learning.

One of the potential short-comings of the communicative approach is that it does not normally create the appropriate conditions for developing automaticity. This is not, however, a necessary deficiency in the approach, but simply a consequence of how it is most often implemented (Gatbonton & Segalowitz, 1988). What is usually missing is a means for creating the sort of repetition that promotes automaticity. Proponents of communicative approaches usually avoid including repetition as part of training because repetition is generally considered to be inimical to the free flow of conversation, the hallmark of genuine communication (see Gatbonton, 1994, introduction).

The opposite problem usually exists in computer assisted language learning contexts. Here there is no difficulty creating conditions where new linguistic information is presented in repetitive fashion. What is difficult is creating interesting, absorbing and genuinely communicative situations that - in the words of Nagy and Herman (1987) which we quoted earlier - establish 'rich ties between new words and prior knowledge' and present 'new words and concepts in the context of larger domains of knowledge'.

Gatbonton and Segalowitz (1988) discuss solutions to the automaticity problem faced by communicative approaches to classroom language learning. Essentially, these involve creating natural reasons, from a communication point of view, for repetition to take place. In the next section we discuss a framework for solutions to the converse problem faced in computer assisted learning - how to create the conditions for genuine communication.

5. Implications for Computer Assisted Learning: So far, we have presented four principal ideas about automaticity and the acquisition of lexical skill that should be relevant to thinking about computer assisted language learning. First, we have seen that lexical skill develops in context in which rich connections are made between new vocabulary items and prior knowledge. Second, consideration of the encoding specificity principle of memory and the importance of transfer appropriate learning means that learning will be optimal under conditions that require genuine communication. Third, lexical fluency implies automatization of skill, that is, restructuring of the underlying cognitive processes to minimize interference and inefficient processing. Fourth, automatization has been seen to occur when learning conditions involve a great deal of consistent repetition.

Ideally, then, the use of computers to assist second language learning should be designed to reflect these ideas. It is not difficult, however, to see that many computer assisted language learning situations are not so designed. For example, vocabulary drill in the context of games usually fails to meet the conditions of learning in context and under conditions of transfer appropriate learning. Programs that foster discussion between users (e.g., Mohan, 1992; Phillips, 1985) usually lack a principled way to meet the conditions of promoting automatizing repetition. We are not aware of any computer based systems that currently do explicitly meet all the conditions outlined above and so for this reason we outline how, in principle, such a language aid might be constructed. This hypothetical example is an extension of a previous analysis of how automaticity can be promoted in communicative language learning situations (Gatbonton, 1994; Gatbonton & Segalowitz, 1988).

Below, we provide a general description of a potential classroom activity that involves the computer as a learning aid and that meets the conditions cited above. We are not concerned here with the technical challenges of how to program a computer to carry out its assigned role which, in this case, is to conduct an interview, compile the results into a data base, and then answer questions based on the information it has compiled (see Stevens, 1992, for discussion of some of the issues involved here). Rather, we are concerned with the psychological role played by the computer in the overall activity. The examples have been kept simple in order to illustrate the main point; in actual practice we would imagine that the network of information stored and accessed by the computer may be more intricate than indicated here.

In its generic form, the activity can be described as follows:

Phase A: The students are first divided into two groups. Each group is given or is asked to generate an information base. The situation is arranged so that there is a need for each student to communicate with the other students in his or her group in order for the group as a whole to have a full understanding of the information base (similar to the idea of 'split' information as described in Nation, 1993). For example, in a lesson for advanced students on vocabulary in the area of economics, students in the group might be asked to construct a composite overview held by experts on some economic issue as revealed across several different reading texts. Alternatively, in a lesson for less advanced students on the terminology of family relationships, students might be asked to construct a hypothetical family tree by negotiating among themselves the position that each member in the group is to occupy in the tree. In both cases, the two groups work separately to master their assigned information.

Phase B: After having cooperatively constructed the assigned information base, each group member 'teaches' this information to the computer. For this purpose, the computer 'interviews' each student (singly or in pairs) and then pieces together the various fragments of information obtained from the different interviewees. In this way the computer comes to possess the full set of facts that each group possesses. Thus, using the family tree example cited above, the computer would be programmed to elicit full sentence answers from each student to questions such as 'How is Makiba related to Pedro in your group's family?', to parse the answers given and to update a data base with the new information. At the end of this phase, the computer will contain its own representation of the information each group has constructed.

Phase C: Next, the two groups compete with each other in attempting to discover the other group's information base by interviewing the computer. For example, this may be a timed race, or a race scored in terms of accuracy, or both. Thus, a student might ask 'How is Ivan related to Marie?' and receive from the computer the answer 'I don't know, but I can tell you how Ivan is related to Sharna', in which case it will be necessary to ask additional questions in order to piece the information together. For example, Ivan might be the son of Sharna who is the sister of Abdul who is the father of Marie, from which the student has to deduce that Ivan is Marie's cousin.

If we extrapolate from past experience with the family tree task (conducted without computer assistance) we expect the lesson to proceed somewhat in the following fashion. In Phase A the members of each group negotiate among themselves who assumes which relationship in a family tree. One student might be designated the father, another the wife of his maternal grandfather's brother, etc. After considerable discussion among the members, agreement is reached on the details, and each student is responsible for understanding and remembering not only their own position in the family but the entire family structure. It is important here that there not be a group secretary to centralize the information. In this way each student must learn the vocabulary and expressions concerned with family relations and, because inevitably there will be some forgetting of who is who, there will be a need for extensive discussion, clarification, etc., all of which creates conditions for genuine communication with inherent repetition. Experience with such tasks has shown us that the groups will inevitably choose 'interesting' - that is, complex - family relationships in order to confound the other group's ability to discover their family tree.

In Phase B, students are interviewed singly or in pairs by the computer outside regular class time. The computer would be equipped with stock questions, phrases and vocabulary items, plus the ability to recognize expected phrases as responses. The language involved here is fairly stereotyped and involves a number of formulaic expressions that can be easily determined beforehand (see Gatbonton, 1994; Gatbonton & Segalowitz, 1988). The information collected by the computer would then be organized into some form that would enable the program to later respond to questions. Inevitably, of course, there will be discrepancies between the facts given to it by the different students. These errors actually create pedagogically useful opportunities because they will require the computer to repeat interview questions, ask for clarification, etc., thereby giving the students occasions to repeat expressions, to make new connections between the key words they have learned and their knowledge, etc. For example, having learned that Pedro is the father, that Chen is the sister-in-law of Pedro's cousin and that Makiba is the daughter of Chen, the computer might ask 'How is Pedro related to Makiba?' It is not difficult to imagine how the computer can be made to be a fairly loquacious interviewer and hence engage the students in extensive dialogue.

Finally, in Phase C the students individually interview the computer to get information about the other group's data base in order to derive the family tree for that group. Often, no doubt, the computer will not understand the questions or not have a ready answer (e.g., it may not have figured out how Pedro and Makiba are

related), and so a great deal of rephrasing and repetition will be involved here too. The students in a given group will have to consult with each other as they piece together the fragments of information they have individually gained about the other team. Again, this generates more repetition, genuine communication and learning in context.

Other examples using more advanced materials can, in principle, be constructed in a similar manner. For example, instead of constructing family trees, the members of each group might be given different reading texts involving the target vocabulary. The texts would be constructed so that they are jointly required to fully understand some particular subject matter, say, the composite viewpoints of a set of experts on a question in science or social policy. The students will have to consult each other to combine all the basic information which has been presented to them in a fragmented way. Then interviews with the computer can proceed as discussed above.

To summarize, the crucial elements in such activities are the following. First, the students are required, by their interactions with fellow group members and with the questions from the computer, to think deeply about the target lexical items. That is, they have to understand a body of information by relating concepts to each other. The computer becomes an inherent part of the larger activity and communication with it involves dealing with new lexical items *in context*.

Second, because of the inherent need for computer/student dialogue, the computer and student enter into a *transfer appropriate learning* situation, one characterized by genuine communication analogous to two people consulting each other. For example, in Phase B each student will want to make sure that the computer has understood the facts correctly about her or his own group (this motivation can be enhanced by including, as part of the competition between groups, a score of each group's overall success in conveying correct information to the computer in the first place). In Phase C each student will want to obtain information from the computer as efficiently and accurately as possible so as to contribute to his or her group's ability to win the race in reconstructing the information base relevant to the other group.

Third, there is a great deal of *inherent repetition* in this activity, much of it promoted by the computer. The computer will repeat questions; it can be programmed to do this when receiving incomprehensible or internally inconsistent information, or even frequently at other (perhaps randomly) 'scheduled' times. The computer's questions and answers will send the students back to their own group members for clarification, which again involves communication with inherent repetition.

Finally, these three conditions - learning in context, a transfer appropriate learning situation, and communication with inherently built in repetition - are expected, on the analysis presented so far, not only to promote increased lexical knowledge, but to result in increased fluency of lexical access. This has special meaning in the present discussion; increased fluency of access means, not just faster access, but access reflecting a streamlined restructuring of underlying processes. We indicated earlier how it is possible to monitor fluency of access by comparing changes over time in the relationship between response time and response time variability. Any of a wide variety of tasks may provide reaction times measures of how quickly the learner is able to semantically process target words; such tasks will yield data suitable for monitoring changes in fluency of lexical access.

6. General Conclusion: We have attempted here to review basic issues in the development of second language lexical skills and to address the question of how computer assisted language learning might enhance lexical fluency. In doing so, we have drawn together insights from several different areas of psychology, including work in the areas of memory, learning and skill development. While it is clear that the advent of computer programs capable of engaging learners in natural communication will provide extremely useful tools for lexical development, we have tried to demonstrate the need to go beyond this particular goal. For a computer program to enhance lexical skill development, it must promote student/computer dialogue within a carefully constructed framework. This framework should be one that respects certain psychological criteria for the student's communication to be genuine, provides conditions for promoting transfer appropriate learning, and has built into it the kind of inherent repetition that automatizes lexical skill. Given the rapid pace of development in this field, and the availability of research techniques to test specific hypotheses about the nature of fluency and automaticity of skill, the prospects are bright for research and applications work on computer assisted language learning for promoting lexical skill development.

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