Serious Games for Second Language Retention

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ABSTRACT

Military personnel who take part in intense periods of second language (L2) training are at risk of losing their second language skills during periods of underutilization. Cycling between immersion and disuse often requires that personnel refresh their skills anew. This paper describes a research effort aimed at maintaining language skills through a deeper understanding of L2 attrition and the implications for the creation of a game-based intelligent training system for L2 retention. Our goal is to promote L2 retention at the conclusion of formal classroom instruction using serious games operating on portable devices. We describe two aspects of the effort: (i) L2 attrition research results and the implications for training systems and (ii) the development of a proof of concept prototype that illustrates the overall L2 retention system. The L2 attrition results include a descriptive delineation between acquisition and retention and identify the critical language skills most at risk during disuse. These inform our portable games, both in terms of language content and game features such as multimedia and multiplayer competition. The system is designed to promote retention for L2 training such as an Iraqi Arabic language course taught by the US Army at Ft. Irwin.

ABOUT THE AUTHORS

Jeremy Ludwig's research areas include intelligent training systems, behavior modeling, and machine learning. In addition to leading the research effort for the game-based second language retention system described in this paper, he has been involved in a number of research projects that utilize game and simulation technology for training. Jeremy was a co-chair for the 2008 AAAI Fall Symposium on Adaptive Agents in Cultural Contexts and has been involved in several tutorials on the use of artificial intelligence techniques in serious games at IITSEC over the past four years. He joined Stottler Henke in the fall of 2000 and holds a PhD in computer science from the University of Oregon.

Dan Fu joined Stottler Henke ten years ago after earning a graduate degree in computer science. He has been involved in the design and implementation of a number of game-based AI systems, which also include intelligent tutoring systems. In earlier work he attended a military intelligence course at Fort Huachuca entitled "Intelligence for Combating Terrorism" to convert the course to an Internet-accessible application. Dan was also PI on an autonomous agents project to create AI authoring tools for simulations and videogames. The project featured a "behavior editor" called SimBionic® which enables users to graphically author entity behavior for a simulation or videogame. Most recently he worked on Informant, which is a training system for Air Force and National Guard information warfare red forces. The game-based system evaluates incoming students to gauge their performance under a stressful situation where they attempt to infiltrate an organization by deceiving its personnel. His work on SimVentive™ resulted in a flexible Java-based editor for creating small-scale wargames for pedagogical use. His ongoing work on RADIX involves the production of demonstrations for the Armor School at Ft. Knox. He holds a computer science Ph.D. from the Univ. of Chicago and a B.S. from Cornell Univ.

Kathleen Bardovi-Harlig's research investigates second language acquisition of tense-aspect and temporal expression through a variety of research frameworks that link form and meaning, interlanguage pragmatics, and the interface of grammar and pragmatics, including most recently the role of conventional expressions. Her publications include several volumes, including the first online book published by the US Department of State, Teaching Pragmatics, and many articles in international refereed journals. She is the former Editor of Language Learning (2002-2005) and the immediate Past President of the American Association for Applied Linguistics. She served as the second language acquisition specialist on the Advisory Board of the National Foreign Language Resource Center (NFLRC), a Title VI center (1993-2006), and as a consultant for the Center for Advanced Study of Language (CASL), a UARC at the University of Maryland. As a consultant to CASL, she participated in the symposium on pragmatics in HLLA (the High-Level Language Acquisition hub), reviewed and synthesized the existing literature on high-level attainment of L2 pragmatics; with Dr. Carsten Roever reviewed and synthesized pragmatics research on five critical languages (Arabic, Chinese, Hindi, Korean, and Persian); developed a research design for L2 pragmatics research which was delivered design to five government agencies through CASL.

David Stringer's research deals primarily with how children and adults acquire the mappings between lexical semantics and syntax, as they are exposed to their first language and then subsequent languages. Specific topics of interest include syntactic universals, critical periods in acquisition/attrition, predicate-argument structure, and linguistic encoding of motion events. More general research concerns encompass all formal aspects of first and second language acquisition. He is known for several international publications and conference presentations, and has served as principal investigator on numerous empirical acquisition projects, using a broad range of methodologies: naturalistic data collection, adult preference tasks, elicited production experiments, as well as judgments of grammaticality and truth-value.

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INTRODUCTION

If you are in Iraq and don't understand the instructions "Ogaf tara armee!" or "Thib slaaHak!" you might be shot. — MS&T Magazine, March 2007

The translations for the above are "Stop or I will shoot" and "Put your weapon down", respectively. While they may have learned these phrases at one time, will service personnel deployed (or re-deployed) to Iraq be able to recognize or produce phrases such as these after their language skills start to fade?

Military personnel who take part in intense periods of second language (L2) training are at risk of losing their second language skills when they are deployed to a posting with limited in-country exposure to the second language and when they are recalled for additional training in other non-language skills. This loss of second language skills (attrition) requires more instruction, costly both in terms of time and money. To prevent this loss of skills, it would be ideal if personnel could make use of language training software aimed at L2 retention during these attrition periods. Unfortunately, no such software targeted specifically at L2 retention currently exists.

This paper describes a research effort aimed at maintaining language skills through a deeper understanding of L2 attrition and the implications for the creation of a game-based L2 retention system. Our goal is to promote L2 retention at the conclusion of formal classroom instruction using serious games operating on portable devices. We describe the two main aspects of the research effort: (i) a review of L2 attrition research results and the implications for training systems and (ii) the development of a proof of concept prototype that illustrates the overall L2 retention system.

L2 ATTRITION

Language attrition, and its counterparts language retention and retrieval, is a topic of great theoretical and practical importance in second language acquisition. Essential questions in this growing but poorly understood field include whether language is actually lost after periods of no exposure or whether it is retained but difficult to access. First language (L1) research suggests the latter, and that periods of intense instruction may lead to revived language retrieval. It also remains to be demonstrated to what degree a language must be learned or stabilized in order to prevent attrition or promote retention. Previous research has left unanswered the question of a threshold of competence. In spite of the proliferation of recent studies and non-refereed work on pedagogy, few rigorous empirical studies have been conducted in this domain and little is known about which parts of language are most subject to attrition and which types of retention instruction technologies are likely to be most effective.

The first objective in this research effort was to review the L2 attrition literature with an eye towards developing a model for the assessment of L2 attrition and identifying areas where more research is needed. The detailed results of this review can be found in a separate journal article (Bardovi-Harlig & Stringer, to appear). In this paper, we focus on the differences between acquisition and retention found while working towards this model. These differences define how software designed for language retention might differ from the numerous existing programs for computer assisted language learning (CALL).

Differences between Acquisition and Retention

Retention differs from acquisition in at least three ways: (i) in the process of acquisition, retention is a substage of the acquisition process that occurs when L2 input is no longer available; (ii) the learner must be motivated to make a conscious decision to combat potential attrition by seeking additional input and opportunities for use; and (iii) in pedagogical approaches to retention, instruction would differ from language instruction in being primarily focused on those areas that are at greatest risk for attrition.

Retention

From the broadest acquisitional perspective, attrition is one possible outcome of second language acquisition. When input is no longer available, either through cessation of study or change in environment, or when language use declines significantly, attrition begins. Attrition is an avoidable path if input and use are maintained. Retention, defined as the prevention of previously attained language competence through focused intervention, is part of the acquisition cycle, but is always external to that cycle effected consciously by the learners themselves or by institutions (schools, universities, or employers) that have a specific interest in language maintenance.

Motiviation

Whereas second language acquisition may occur in an intentional setting such as classrooms or self-study or unintentional situations (such as speaking to neighbors when living abroad), language retention is always a conscious act that involves the seeking out of opportunities for second language input and use when the natural involvement in both has ceased (such as the end of a course or a change in positing or deployment). Thus, although the psycholinguistic processes of language retention may in large part mirror those of acquisition, the conscious act of setting a goal of retention–rather than following the natural path to attrition–characterizes retention. Work by Gardner and colleagues (Gardner, Lalonde, & MacPherson, 1985 ; Gardner, Lalonde, Moorcroft, & Evers, 1987) has suggested that, as in L2 acquisition, in L2 attrition/retention, motivation plays a significant role.

Pedagogical Approaches

One fundamental difference between acquisition and retention is that the former involves the establishing of linguistic rules and representations in the mind for the first time, while the latter involves stimulating, through repeated use variations on rules and representations that have previously been established. Thus the meta-linguistic information (descriptions of the grammar, translations into the native language, etc.) typically associated with language learning in formal classroom environments and self-study in immersion environments does not necessarily benefit from repetition in retention scenarios. While conscious reflection may be useful for first-time acquisition (especially of vocabulary and idioms), retention may be possible by reactivating linguistic knowledge by means of exposure and elicited production in more naturalistic contexts, with explanation only to be sought if necessary. If real-world contexts are no longer accessible, such contexts can be simulated in a virtual world. Retention materials focusing on re-exposure to language in context may therefore be quite distinct from learning materials designed for first-time instruction.

While second language instruction can follow (although perhaps not ideally) a variety of paths and practices, second language retention may be best promoted by a considerably narrower set of practices in which interactive production is emphasized. In discussing instruction, it is necessary to distinguish between two paths to L2 knowledge: learning and acquisition (Krashen, 1976), and two types of L2 knowledge: explicit and implicit (Bialystok, 1978). Knowledge about a language (*explicit* knowledge derived from conscious *learning*) –for example, being able to state rules, knowing how many verb classes there are, or being able to recite a paradigm–is hypothesized to be quite distinct from knowledge *of* a language (*implicit* knowledge derived from unconscious *acquisition*) which is comprised of a natural language grammar which underlies spontaneous use and understanding in real time production and comprehension. (Applying rules or *monitoring*, requires a focus on form, knowledge of a rule or rules, and above all, time to apply that knowledge.) Some instructional approaches result in explicit knowledge or a combination of explicit and implicit knowledge. We propose that retention activities should focus on the latter–activities that promote and strengthen implicit, acquisitional, L2 knowledge.

Additionally, for the purpose of planning interventions to retard attrition, an important difference between acquisition and retention is at the level of practice: namely, the design and implementation of retention materials and activities. A cautionary tale from Yoshitomi (1999) warns that mere contact with the L2 alone is not sufficient to promote retention; rote classroom activities with little interaction hold little promise for language maintenance. More general attrition studies support this as well: production is at greater risk of attrition, and production in populations without the support of literacy is at greatest risk.

A third decision unique to retention must also be addressed and that is whether to focus on what we will call *review only* and *review plus*. Review only refers to retention materials and activities limited exclusively to the content previously presented during pre-departure language training. Even if review only were possible–and this will be complicated by the participation of learners with different initial language training experiences–repetition of a relatively small, closed set

of items and structures could be rather tedious for the learners. Review plus takes into account the materials used in the initial training (where possible), incorporating additional vocabulary and grammar to strengthen and enrich the linguistic system. This is not a wholesale development of new lessons, but neither is it a slavish adherence to the "old" material. This is the preferred path for a number of reasons: introduction of novel but related material helps (1) linguistic systems become better anchored, (2) reduces potential boredom with a closed set of content, (3) increases challenge and competition (with self and others) for gaming and self-study, offering users the opportunity to reach higher levels, (4) allows multiple words, expressions, and structures for ease of retrieval, (5) increases confidence in language use in multiple settings, and (6) accommodates a learner population at multiple levels of competence.

In addition to targeting areas of language knowledge that are most at risk, as discussed earlier, populations differ in their characteristics, their accomplishments (level of attainment) and communicative goals, among other variables. It is instructive to consider types of retention activities for two populations: a survival skills group and an advanced group. The survival skills group has had minimal language instruction such as a short pre-departure military training course (e.g., the Fort Irwin 40 hour training in Arabic) or self-study (e.g., Japanese for Busy People, Association for Japanese-Language Teaching, 1984). Such a group has minimal literacy skills, especially in non-roman alphabets or writing systems, but may have some familiarity with a pedagogical romanized writing system created for teaching-learning purposes. (Such a system supports acquisition and retention, but is limited exclusively to pedagogical contexts for languages such as Arabic, as it is very rarely found in natural social contexts such as newspapers, billboards, or magazines). We assume that the survival skills group has learned so little that they will initially only recognize the phrases they have been taught (e.g., 'Put your hands on the car'), so it is much more important to begin retention training with an exact match with the initial instructional materials. Literacy support should also be implemented, either introduced or reintroduced, to aid retention and allow learners to take notes to aid memory and to convey simple messages to other learners. Eventually, through practice of various types, learners will learn to parse sentences into component parts so that they will know implicitly that expressions like "the car" in "put your hand on the car" can be changed to "put your hands on the wall" as situations require.

The second group whom we will call "advanced" has either longer periods of language instruction or longer periods of contact that have resulted in higher proficiency in the target language. These learners are literate in the L2, and thus authentic street signs, billboards, newspaper headings, warnings, and banners can be used designing virtual contexts for retention instruction. The retention goals for this group include maintaining their higher level of proficiency reached while in the host environment (or in the classroom) and strengthening communication skills. By offering opportunities for production in a variety of simulated contexts and with a variety of speakers, retention activities will promote ease of production and increase pragmatic competence while offering practice in content, vocabulary, and grammar. As mentioned earlier, production in real time is at the greatest risk for attrition and materials and activities should provide learners with opportunities to maintain retrieval with speed and accuracy.

Implications for Training Systems

A number of implications for an L2 retention system fall out of this research. These implications are divided into two rough categories: instructional and motivational. Instructional implications include what activities and content to focus on as well as how to select them. Motivational implications center around the perceived utility of instruction, the availability of instruction, and leveraging motivation features commonly used in computer games. Note that some of these implications are taken directly from the L2 retention research (e.g., focus on production) while others are possible solutions for issues described in the research (e.g., using game-based techniques to address motivation).

Instructional Implications

First, since production skills are likely to be more vulnerable to attrition than receptive skills, it is important that learners are asked to reply to content that is spoken to them and to speak phrases at the appropriate time. Conversational attributes that promote retrieval and use of language in a timely fashion (e.g., turn-taking) will encourage the practice of rapid response and processing skills. Additionally, the student needs to receive feedback on their pronunciation skills. This could occur on the phoneme, word, or sentence level.

Second, as one L2 retention group is defined as military / business / student populations with modest language skills, any retention system needs to build directly from the lexicon they are already familiar with.

However, the system should also introduce new material as retention of existing material is demonstrated. The lexicon is also a focus area in that it seems to attrite before grammar for advanced users, while for more modest learners there is only the lexicon.

Third, any retention system should select lexicon items and activities from the possible pool of items and activities so as to maximize language retention by taking advantage of techniques from intelligent tutoring systems. Two methods to achieve this are spaced repetition and leveraging domain knowledge. For example, in the first case a phoneme would come up for pronunciation practice based on when it was last practiced and the associated level of mastery. In the second case, the same phoneme would be presented if the student has trouble pronouncing several words that all contain the same phoneme.

Motivation Implications

First, the retention instruction must be perceived to be useful. For example, business travelers maintaining their L2 skills do not want to encounter phrases about riding horses. One way to address this is to accept input from the learners themselves about what aspect of the curriculum is most important. This could be done by including the capability to rate words / phrases in the lexicon and to provide blogging-style comments. This information could both serve to reinforce the importance of language retention (via personal stories) and to inform the selection of lexicon items and activities for reinforcement.

Second, instruction should be available at any time so that it can be used whenever the learner has some amount of 'free time'. This means that instruction should not be tied to a desktop computer – a cell phone based application can be used to maintain language skills when the student is standing in line, riding the subway, etc. The idea is that students will be more likely to actually take advantage of retention instruction if it can fit into their already busy schedule. Some anecdotal results (McNicol, 2004) provide evidence for the efficacy of this approach, where it was reported that most users of a specific L2 acquisition program delivered via cell phones resulted in one hour of training per day, broken into six or seven individual sessions.

Third, a retention system should leverage motivational concepts commonly found in computer games (and serious games). One common motivational technique in computer games is to provide general feedback (i.e. a score) that is visible to the user at all times. This gives the learner a sense of the current state of their progress and allows the user to compare themselves to their peers and to set their own learning goals (Phillips, 2009). Another common technique is allowing users to progress to new "levels" based on their performance. For example, a basic form of instruction common across most CALL software are question and answer activities, such as multiple-choice questions. However, as described previously, retention software also needs to make use of more engaging scenario-based language activities where the student participates in a conversation. Once the student has demonstrated retention through standard instructional activities they would then unlock a more advanced game or activity (e.g. scenario-based instructional activity) that builds on the pre-requisite words / phrases. A separate display screen would present the user with a list of the locked / unlocked items so they can measure their progress. Yet another common motivational technique is to support multi-player games, as evidenced by the popularity of on-line computer games. Retention instruction should take of advantage of this by supporting both single- and multi- player modes that make use of the same activities, content, and games.

L2 RETENTION PROTOTYPE

In developing the proof-of-concept prototype, we elected to focus on the final two motivational implications: providing instruction on a portable device and leveraging game concepts for motivational purposes in L2 retention instruction. This section provides an overview of retention prototype that serves as an illustration of particular aspects of a larger retention system. With this prototype we were not able to perform any experiments to generate data that could be used to validate our retention hypotheses; such experiments are planned as part of future work.

Overview of Retention Prototype

The L2 attrition research and the resulting implications informed our efforts to create a proof-of-concept prototype. Early on we identified the two chief risks as:

1. Technical development: What portable devices can support language training games? Which features (touch screen, internet access, wireless connectivity, speech recognition, GPS, accelerometer, ease of dissemination, etc.) are critical?
2. Motivation: By creating small-scale language training games is it possible to create activities that will motivate individuals to engage in retention?

Our technical investigation yielded the iPhone / iPod Touch as the best platform given potential technical requirements, base of users, and quality of development program. Google's Android was also considered, but its popularity has yet to be established which is a commercialization concern. We explored the uses of four iPhone features:

1. Touch screen: Affords ease of use, enabling users to touch the screen rather than press arrow buttons.
2. Multimedia display: Play full motion video and sound.
3. Wireless communications: Enable several learners to interact using the portable device.
4. Additional sensors: We experimented with the iPhone's accelerometer which can detect the device's orientation with respect to gravity.

Ultimately we designed and implemented four learning activities, two of which enable multiple learners to participate together in friendly competition. Table 1 lists the games and describes them, followed by four figures that describe the activities.

Table 1: Prototype learning activity / game descriptions.

		Mode	
		Single player	**Multiplayer**
Learning Activity / Game	**Trivia (see** Figure 1**)**	Answer trivia questions in a multiple choice answer format. Scores based on time and correctness of answers.	Same as single player except questions are synchronized among multiple players. Scores are broadcasted to all players.
	Video (see Figure 2**)**	View video enactment of culture/language scenario. Answer questions about the video or choose next actions.	N/A
	Word Order (see Figure 3**)**	Arrange words to form a coherent sentence or phrase. Scores based on time to complete.	N/A
	Maze (see Figure 4**)**	Tilt device to navigate a pinball through a maze. Engage in language activities when encountering barriers in the maze.	Same as single player except player location in the maze is broadcast to all competitors.

In examining existing computer assisted language learning (CALL) software (including existing iPhone language programs), we divided instructional activities into four categories:

1. Passive: Listening to audio, watching video, with no interaction or feedback. This is a common way to deliver existing materials for the iPhone/iPod.
2. Question and Answer: Picture-word association, fill in the blank, watching a video followed by multiple choice questions, and turn-taking in a simulated conversation all fall into this category. The student might read or listen to the question while seeing static images, video, or 3-D simulation and then speak or select the answer.
3. Pronunciation: Pronunciation activities provide narrowly focused practice and feedback with speaking phonemes, words, and sentences.
4. Games: Instructional games provide a richer context for other instructional activities (Q&A, pronunciation), tying a series of activities together. Instructional games can take almost any form, from casual games such as crossword puzzles to synthetic immersive 3-D environments that send the user on a series of communicative quests.

The first two activities in the prototype (Trivia, Video) are examples of question and answer instructional activities. The prototype demonstrates what we envision these activities will look like on the iPhone, video capabilities of the mobile platform, as well as network communication over WiFi to support multiple, competing, players. Word Order is an example of a puzzle-type of game-based activity, also commonly seen in CALL programs. This game demonstrates using the touch screen on the iPhone to drag words into the correct location in phrases. Maze is a casual instructional game created specifically for the iPhone platform. It demonstrates both using some of the sensors on the iPhone (not commonly found in desktop/notebook training environments) as well as multi-player capability through WiFi. This game provides an interesting context to existing question and answer activities. There is also an element of competitiveness to this game as the player tries to make it through the maze more quickly than their opponent.

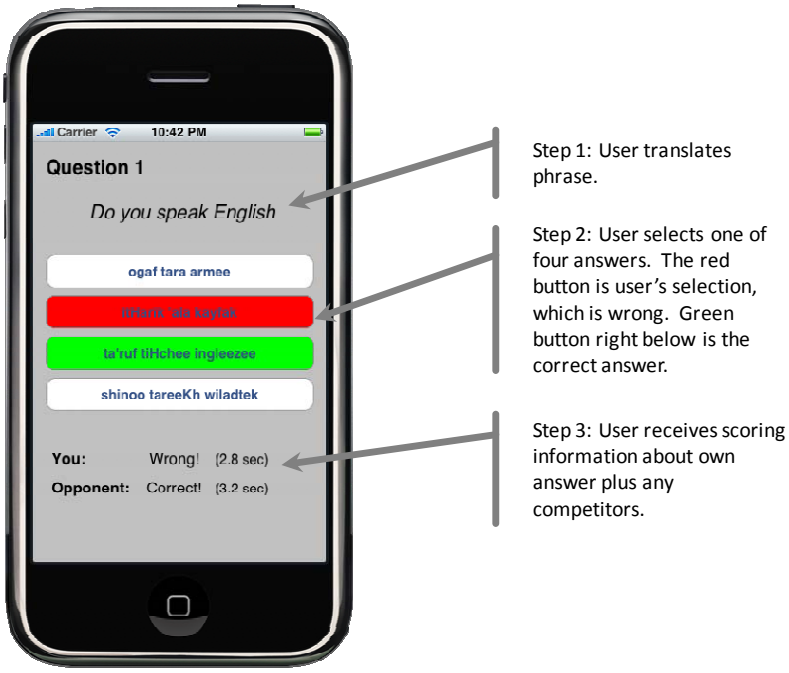

Figure 1: Trivia contest.

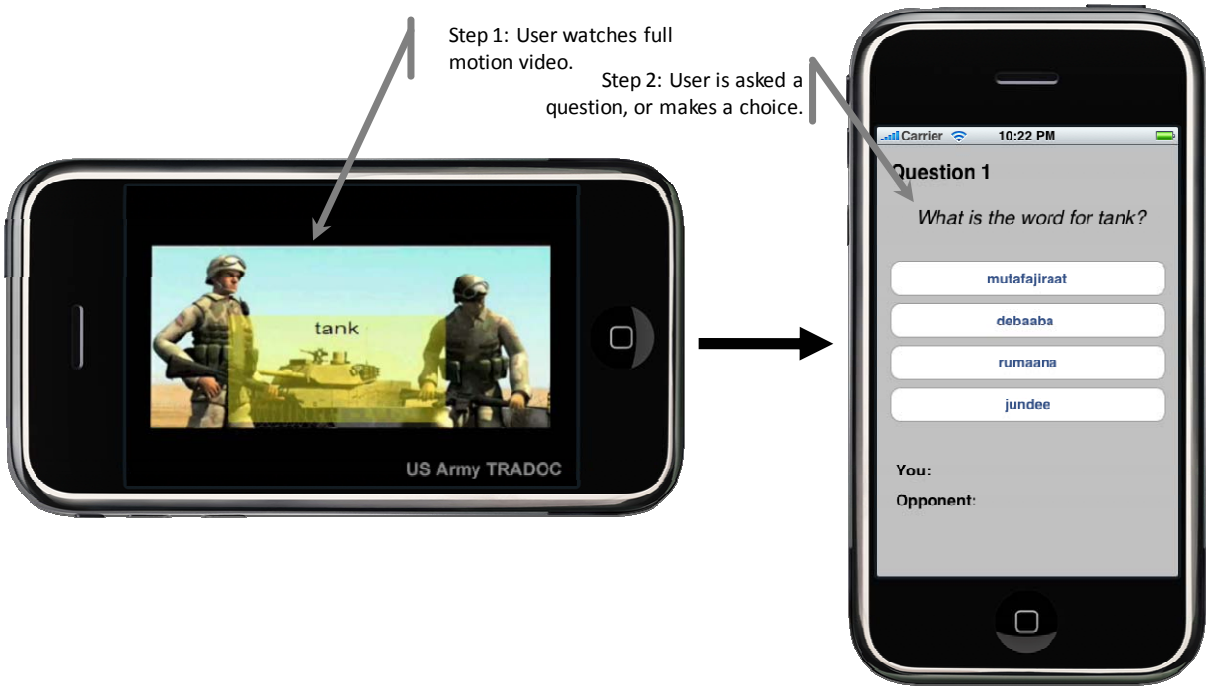

Figure 2: Video-based questions or choose-your-own-adventure.

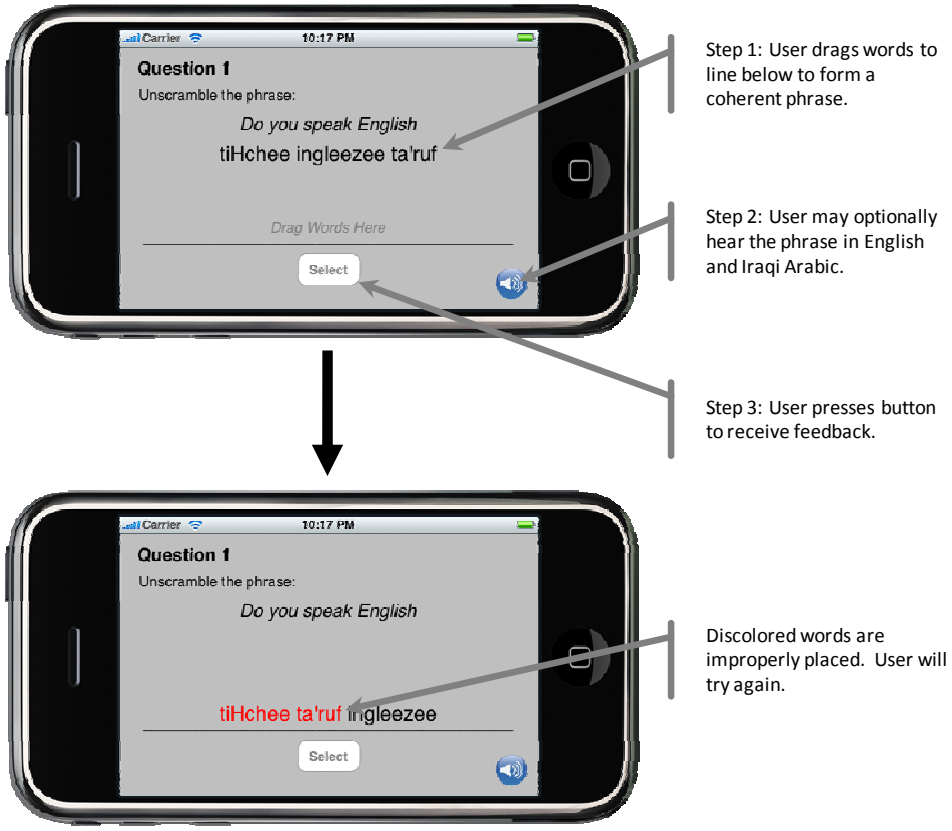

Figure 3: Word order game.

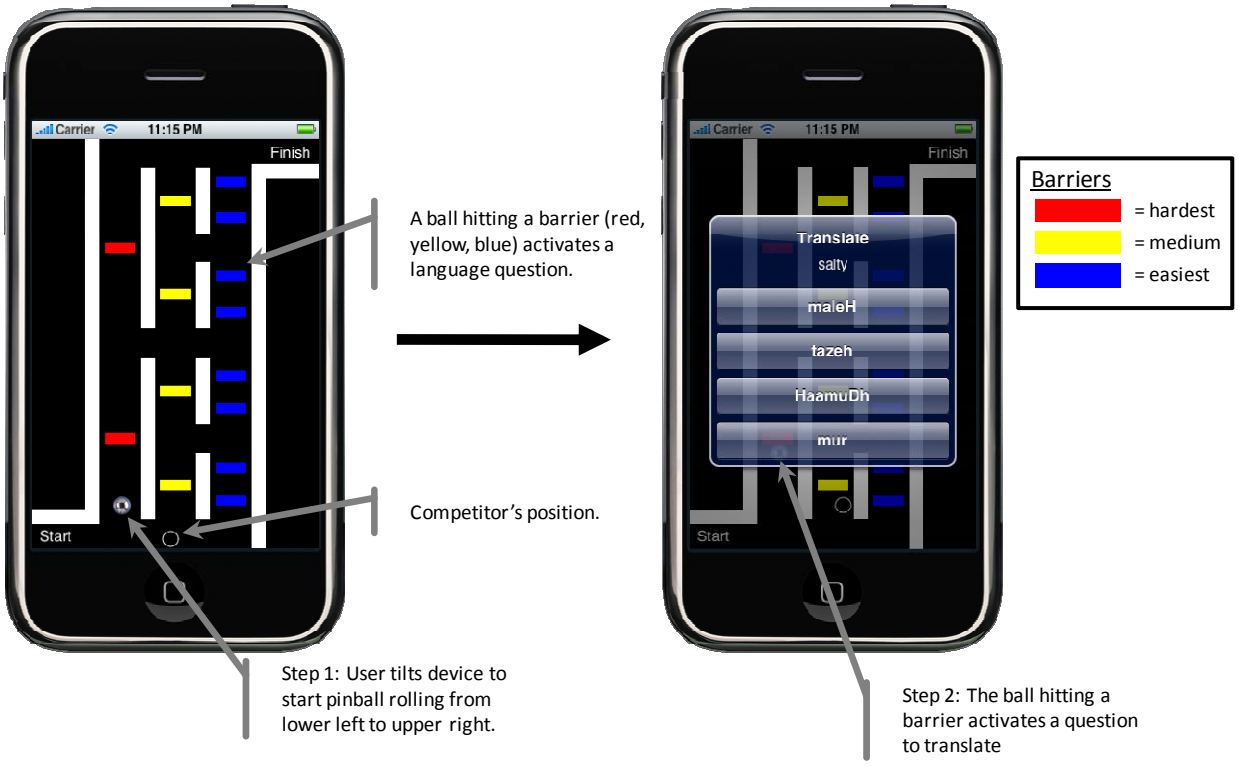

Figure 4: Maze game.

From informal feedback and demonstrations, the multiplayer version of the Maze casual game (Figure 4) is deemed to be our most engaging application; i.e., that learners would be motivated enough to play it on their own time. We believe there are two reasons:

1. Social: Learners can engage in competitive play. They are playing nearby each other which always results in conversations happening during the session.
2. Immediate feedback: Learners can track their progress easily by simply noting their distance to the finish line. They can also see each other's progress.

While this prototype focuses primarily on demonstrating mobile delivery of game-based L2 retention activities, it illustrates some of the more interesting features of a complete retention system.

CONCLUSION

In summary, we described our research efforts aimed at maintaining language skills through a deeper understanding of L2 attrition and the implications for the creation of a game-based L2 retention intelligent training system. Towards this end, this paper provides both (i) a summary of our research on L2 attrition and the implications of this research for a retention system and (ii) an overview of a prototype retention system developed for the iPhone platform that includes novel instructional activities and multi-player capabilities.

There is a significant amount of future work to be done to realize the envisioned retention system. First, the number and diversity of instructional activities need to be expanded to include the full range of CALL activities as well as additional instructional games (both casual and immersive) developed specifically for the iPhone. Two especially important kinds of activities, as identified in the literature implications, are scenario-based activities that require the student to produce answers on demand in simulated conversations and activities that provide feedback for all levels of pronunciation. Given the proliferation of 3-D modeling tools for the iPhone platform, creating immersive simulations should not be technically difficult. However, voice recognition and pronunciation feedback could be challenging.

Second, these activities need to be configured to work with content from an existing language/culture course such as an Iraqi Arabic language course taught by the US Army at Ft. Irwin or courses from a university's study abroad program.

Finally, we need to develop a model for the assessment of L2 attrition and then evaluate the efficacy of the retention system when used by the specific user group. This study would provide evidence about the utility of the retention software.

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