Human–computer interaction in second language word acquisition

A qualitative study on Peruvians’ use of computers to learn new words in Swedish

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Abstract

The program for language learning *Svenska för invandrare* (Swedish for newcomers) has only a small amount of students who complete the program successfully. The use of computers could help students and educators increase the amount of success. A review of the research on second language word acquisition in human–computer interaction suggests that there is lack of studies, especially qualitative ones, in the area. For this reason, the following pilot study explores the possibilities of using audio-visual recordings of open interviews during tasks in order to analyze human–computer interaction and discuss how it enhances or limits Swedish as a second language word acquisition. With this ambition, qualitative information about how four participants looked up the meaning of a few, selected, words on a computer was gathered through recording their interactions and comments. The results of the study are discussed from a cognitive perspective to determine which interactions enhanced, or limited, second language word acquisition. The results preliminary suggest that the use of images and dictionaries of synonyms could enhance word acquisition. However, the use of strategies to avoid writing or holding unknown words in memory, the use of online translating services, changing prefixes and suffixes to generate new queries, and the use of a search engine’s results as an information source, could limit L2 word acquisition for this particular group.
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1 Introduction

It is often said that language is the key to understanding another culture. According to this statement, learning the local language of a new society becomes a necessity for immigrants if they want to integrate into that society. For this reason every municipality in Sweden is responsible for offering newcomers basic Swedish language courses. These courses are called Svenska för invandrare [En: Swedish for immigrants] (SFI). The syllabus of these courses comprises five areas: listening comprehension, reading comprehension, verbal interaction, verbal production and written skills (Skolverket, n.d.).

Even if SFI is beneficial for learning Swedish, a survey made by Statistiska Centralbyrån (SCB, 2009) (with 460,000 SFI students who moved to Sweden between 1993 and 2007, and were still registered there in 2009) shows that only half of them succeeded in the Swedish course. These results reveal the necessity of researching second language teaching methods and techniques in order to improve language learning and increase SFI’s success rates.

In an interview with a Swedish teacher, made by the author of this report, the idea arose of studying and improving computer assistance in word acquisition, a basic step to achieving SFI’s five goals. This method could give the students the opportunity to increase their vocabulary outside the classroom more efficiently. In the classroom, an increase of student vocabulary could give teachers more time to focus on their teaching and should prevent questions about words’ meanings from affecting the flow of a lesson. These are aspects that could lead to improved language learning and higher success rates for SFI.

Recent research into second language word acquisition with computer assistance often focuses on computer mediated communication (Shadiev, Hwang, & Huang, 2017; Sauro & Smith, 2010; Kötter, 2003; Zheng, Wagner, Young & Brewer, 2009; Lamy & Flewitt, 2011; Chapelle, 2005), while the study of human–computer interaction (HCI) has been neglected (Ellis, 1999a). This lack of research suggests the necessity to explore HCI in computer assisted word acquisition in order to develop the research field.

Regarding the lack of research described in the previous paragraph, the present paper explores the possibilities of using audio-visual recordings in open interviews during a specific task in order to analyze HCI. This technique is used in this particular study to find out how HCI limits or improves second language word acquisition. To be more precise, the present paper explores the following question:

*How does human–computer interaction improve and limit Swedish as a second language word acquisition?*
2 Previous research

At the moment of writing this study, there is no available theory of second language word acquisition in HCI to the best of our knowledge. For this reason, the present research is based on a theory of second language acquisition which is put in relation to theories on the relevant cognitive processes used in HCI (perception and the long term store). These theories are explained below.

2.1 Interaction in second language acquisition

To understand how computers affect second language acquisition (SLA) it is necessary to first understand what second language acquisition is and how it works. This section explains terms commonly used in SLA followed by a review of a specific version SLA theory, the interaction theory.

Languages that a person inherits from her caregivers are called her first languages. Unlike a first language, a second language (L2) is a foreign language learned later in life and it is not necessarily spoken by the person’s caregivers. SLA refers to the informal learning of an L2 in everyday life. Besides this, SLA also refers to the situation in which an L2 is the main language in a learner’s home society (Yule, 2010; Abrahamsson, 2009; Krashen, 1982).

According to the APA dictionary of psychology (n.d.) “interaction” is “a relationship between two or more systems, people, or groups that results in mutual or reciprocal influence”. Moreover, human interaction with an object can achieve scaffolding if this object delivers temporary support or assistance for the human to accomplish a specific activity until the learning of this specific knowledge or skill is accomplished (Lave & Wagner, 1991; Lajoie & Derry, 1993). SLA distinguishes between three types of human interaction that are capable of scaffolding L2: the inter-personal, intra-personal and HCI (Ellis, 1999a; Lave & Wagner, 1991; Rogoff, 2003).

The interaction hypothesis (IH) explains that SLA happens when a learner interacts with her environment using the L2. This means that she is exposed to comprehensible expressions (comprehensible input) in the L2 and/or uses the L2 in interaction with another agent (output) (Ellis, 1999b; Zheng, Wagner, Young, & Brewer, 2009; Kotter, 2003; Muho & Kurani, 2011; Krashen, 1982; Xien & Ellils, 1999).

2.2 Perception

Human interaction happens through perception (Wilson & Clark, 2009). For this reason, this section explains how visual and auditory perception work and how they are connected with the long-term store (to store information) in order to understand how scaffolding in L2 word acquisition works.

Baddeley (2000, 2003) suggests that visual and auditory perception is processed by two different systems, the phonological loop and the visuospatial sketchpad. The phonological loop is a limited capacity storage system that process verbal and acoustic information from the environment. To retain information in memory, this storage system loops the perceived information, producing sub-vocal speech or the mental voice we hear when we read. Because of the system’s importance in the use of language, the phonological loop is related to language learning. The capacity of retention in the phonological loop is influenced, for instance, by the sound relation between items in a series. Series of similar items are shown to
be more prone to loss than dissimilar series. Another particularity of the phonological loop is that the retention of long lists of verbal and/or acoustic information is affected by the meaning relation between the items. Lists of items with a meaning relation between them achieve a more durable trace than those without this relation (Baddeley, 2003, 2000). The visuospatial sketchpad, on the other hand, is a limited capacity storage system that holds and manipulates visual and spatial information which can originate both from visual perception and from verbal descriptions. This visual storage system can hold about three or four objects at the same time (Baddeley, 2000, 2003). When the phonological loop or the visuospatial sketchpad exceeds its process capacity, it elicits a phenomenon called bottleneck. This phenomenon increases the tendency to discard exceeding information in the affected storage system (Smith & Kosslyn, 2009).

2.3 The long-term store
The long term store (LTS) is a mental storage system which can hold large amounts of information from perception for long periods of time. Information can be stored in the LTS in three ways: elaboration, the generation effect and the spacing effect. Elaboration is the process of generating relationships between an individual’s perceived and previous knowledge, the generation effect is achieved when clues are used as memory aids in order to generate information, and the spacing effect is the retrieval of information spaced out in time (Craik & Lockhart, 1972; Wittrock, 2009; Smith & Kosslyn, 2009).

2.4 Research principles
Ellis (1999b) suggests that research on L2 should regard certain word properties which can influence the incidental vocabulary acquisition from a text. The first property is called part of the speech, which is the distinctiveness of a word according to its function in a sentence (Ellis, 1999b). The relevant parts of the speech used in this study are nouns, pronouns, verbs, adverbs, adjectives, conjunctions, prepositions and interjections (Teleman, Hellberg & Andersson, 1999). The second property is called length of word form and it addresses the quantity of letters or syllables of a word (Ellis, 1999b). The third and last property is called polysemy, which addresses the distinction of words according to the number of different meanings they have (Ellis, 1999b).

3 Method and data collection
Since this study aims to explore the possibilities of using audio-visual recording during a task, this section is devoted to explaining in detail the method and data collection procedures of the study.

The present study was designed to gather as much information as possible about the qualities of the participants’ interaction with the computer while learning L2 words. To collect the data, audio-visual recordings of the participants doing a specific task were done. The expected outcome of the study was a description of how a certain cultural group interacts with a computer while learning L2 words.

3.1 The task
Considering the time that would take to capture the phenomena in natural settings and the amount of data to analyse that it would generate, a task was designed by the researcher in
order to elicit the activity in focus for the study. The participants’ task was to receive, one by one, a number of cards, each of which contained a sentence with a target word, and to then use the computer to find the meaning of the specific word.

In the execution of the study, the use of a task had an influence on one participant who acknowledged that being in a task situation made him feel more insecure about the meaning of the words.

3.2 The equipment

In order to carry out the study it was necessary to use a computer, a list of target words and a set of cards each containing a sentence. Each part of the equipment is explained below in more detail.

The computer used during the study was the researcher’s personal computer. The computer had an embedded webcam and microphone and it had pre-installed the screen recorder Camtasia Studio.

The list with target words (attachment 1) was compiled by the researcher. Each one of the words on the list was chosen to arrive at a list that included all the following parts of the speech: noun, pronoun, verb, adverb, adjective, conjunction, preposition and interjection. Moreover, words were chosen within three arbitrary lengths: the short words had one or two syllables, the medium words had four or five syllables, and the long words had six or more syllables.

The words on the list were found by searching in Google for wordlists in Swedish containing one specific part of the speech at a time. The words on the result lists were then filtered choosing the ones that were regarded by the researcher as not commonly used in everyday speech. These words were then grouped by their length to filter them by their polysemy (quantity of meanings). Because of the low quantity of target words, no word was filtered by polysemy. In most cases two or three words with the same properties were chosen to provide alternative words if needed. The ultimate list contains forty-seven words, divided in nineteen groups containing words with the same characteristics (attachment 1).

The short time frame for the research and the constraints imposed by the word properties led the selection of target words to rely on the researcher’s criteria. It could have been more reliable to create a list of words based on a frequency dictionary.

Finally, the set of cards was also made by the researcher based on the list of target words. Each one of the words in the list was used in a sentence (attachment 2) and each sentence was printed on a card.

3.3 The participants in the pilot study

The present pilot study involves a convenience sampling of four participants. The criterion for the selection of the participants was based on the usefulness of the information they could give. To accomplish the task, it was important that the participants were relatively fluent in Swedish. It was also regarded as important that the participants shared the same cultural background and mother language, which in this case are the Peruvian culture and the Spanish language. To make the sample homogeneous, the participants were decided to be only men. It
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was also decided that participants would not receive a compensation to avoid unwilling participation aiming only at being rewarded.

The chosen participants were four Peruvian men between thirty and forty years old. Besides this, the participants had the following characteristics; see Table 1.

Table 1 Principal characteristics of each of the study’s participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>University studies</th>
<th>Language competence</th>
<th>Age at the time he moved to Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Currently completing</td>
<td>Spanish, Russian, English and Swedish</td>
<td>26</td>
</tr>
<tr>
<td>Participant 2</td>
<td>Not conducted</td>
<td>Spanish and Swedish</td>
<td>15</td>
</tr>
<tr>
<td>Participant 3</td>
<td>Completed (a degree)</td>
<td>Spanish, English and Swedish</td>
<td>5</td>
</tr>
<tr>
<td>Participant 4</td>
<td>Not conducted</td>
<td>Spanish, English and Swedish</td>
<td>30</td>
</tr>
</tbody>
</table>

3.4 The settings

Three out of the four participants accepted to take the test in their homes while one participant preferred to take it in a public café in central Stockholm. Since this is qualitative and not quantitative research, the fact that one participant conducted the task in a different environment does not affect the results. The different background noises in the participants’ specific environments influence the participants in different and unpredicted ways. For this reason, the common behaviours, between the participant who took the test in the café and the other ones, have less probably being affected by the background noise.

3.5 The procedure

Each participant received one by one a set of cards, each one containing a sentence with one target word. Then he was asked if there were any words in the sentence that he did not know. The card was discarded if the participant knew all the words, or gave either an irrelevant answer or two or more words as an answer. He was then allowed to use a computer to look for the meaning of the target word. As soon as the participant showed understanding of the word, the card was discarded in order to continue the test with a new card. The task lasted until the participant searched for the meaning of one word in each of the nineteen word groups.

While searching for the word the participant was encouraged to talk about and explain what he was doing. If the participant remained silent or if the researcher wanted to inquire further into his thoughts, the participant was asked follow-up questions. These questions were asked specifically about aspects of the task that felt interesting for the study and no one of these questions were previously arranged or prepared in advanced.

In the execution of the tests, one participant discovered links used by a previous participant. This issue happened two times during the participant’s test. Consequently, the data from each affected task was voided from the moment the participant discovered the used link until the end of the task. After that incident, the visited links registry was erased before each test with a new participant.
3.6 The recordings

The recordings were done with the screen recorder which captured the screen, the image of the participant through the computer’s webcam and the ambient sound through the microphone. The screen was recorded in order to capture the participant’s interactions with the computer’s interface. The image of the participant through the webcam was recorded in order to capture the participant physical interactions with the environment. And the ambient sound was recorded to capture the participant’s comments and the environment sound. All the recordings started right before the handing over of the first card and lasted for the entire task without interruptions until the last card was discarded.

3.7 The analysis

The analysis process started with the transcription of the data. Two aspects of the recordings were transcribed, first the conversation and then the interactions with the computer. The conversation was transcribed in a text file, in which the interactions with the computer were added as text descriptions. Screenshots of the video recordings were also added to the text to explain certain interactions. Because each target word had different characteristics, the entire searching for the meaning of each word was regarded as a case study, which means that they were isolated from each other.

The transcriptions were then read several times in order to understand them in depth. After this, almost every expression and interaction in the transcriptions was assigned a theme, a word that described the essence of the interaction (see attachment 3). Themes with many expressions were assigned sub-themes in order to make a more refined thematisation. The thematized data was then sorted in three different ways in order to find similar expressions/interactions from different sources. First, the data was arranged according to their theme and sub-theme, then according to the target word’s part of speech, and then by word length.

3.8 Research scope and limitations

This research focuses on how the interaction between a computer and a language learner can affect L2 word acquisition. Perception and memory in HCI are considered broad enough research areas to be the focus of further studies. In order to narrow the focus of this study these areas are therefore partially left out. More precisely, participants’ perception and memory are not tested and thus neither explained nor discussed in depth.

3.9 Ethical measures

Before each test a briefing with the participant was carried out. This briefing contained information about the participants’ voluntary involvement, their right to abort the research when they felt like it, the purpose of the research, the institution responsible for the research, the data gathering methods, and the privacy of the data (Vetenskapsrådet, 2002).

Besides this, the participants’ identities were coded to assure their anonymity. They were assigned codes from U1 to U4, which stand for user one, user two, and so on (Vetenskapsrådet, 2002).
4 Results

In order to arrive at an answer to the research question, this section presents the recurrent and relevant interactions as the results from the study. As this study explores the possibilities to use the present method, it is important to show the outcome in detail. For this reason the results of the study are presented together with explanations about the findings, excerpts of the original translations and screenshots.

A summary of the relevant themes found in this research are shown in Table 2.

<table>
<thead>
<tr>
<th>theme</th>
<th>sub-theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>representations</td>
<td>elaboration - chart/example/image/text</td>
</tr>
<tr>
<td>off-loading strategies</td>
<td>N/A</td>
</tr>
<tr>
<td>divided attention</td>
<td>N/A</td>
</tr>
<tr>
<td>search strategies</td>
<td>- for pronouns, adverbs, adjectives, conjunctions, prepositions, and interjections.</td>
</tr>
<tr>
<td></td>
<td>- for nouns and verbs.</td>
</tr>
<tr>
<td></td>
<td>- information sources.</td>
</tr>
<tr>
<td></td>
<td>- search query.</td>
</tr>
</tbody>
</table>

4.1 Representations

The information about the meaning of the target word provided by the computer was found in different representation forms, for instance, translations, synonyms, descriptions, images, charts and examples. The results show that participants found information about the meaning of nouns either in images or making an elaborate search (gathering information from several pages). In comparison with an elaborate search, images were more efficient in providing the participant with enough information because they made it instantly.

In the examples below, participant 3 (excerpt 1 and image 1) and participant 1 (excerpt 2 and image 2) searched for the meaning of the target word in a search engine, finding images among the results.

[Interaction] The user clicks on “Do you mean tundra?”
U3: Tundra and then I will go to pictures.
[Interaction] The user clicks on the tab Images.
U3: Because I want to see more or less ... that’s roughly what I imagine ... sure! Tundra ... something open ... like an ... open environment. I don’t know how to say it in Spanish but... sure! Where there is no forest, that’s what I imagined ... like this...

**Excerpt 1** Participant 3 explains that he is searching for pictures related to the target word.
The result from the search for the target word ‘tundra’ by participant 3, showing images as part of the results.

M: What are you looking at?
UI: The image. I thought that it was an object but it turns out to be a bird. This bird, that is typical of north Europe.

Participant 1 explains that he understood the meaning of the word ‘tornseglare’ from a picture in the search engine’s result.

Image 2 The result of participant 3’s search for the target word ‘tornseglare’, showing images as part of the results.

4.2 Off-loading

Some participants showed approaches related to the off-loading of writing, like cutting and pasting words from one page to another, changing an old request to fit the new search and the use of the right click to correct misspelled words.

In this example, participant 2 (image 3) and participant 4 (excerpt 3 and image 4) showed how they copied an already written word to paste it as a query into another page.
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**Image 3** Participant 2 copies the word ‘kulturminnesmärker’ to paste it into another page.

**Excerpt 3** Participant 4 copies the target word and pastes it into a new page to start a new search.

4.3 Divided attention

The results showed that participants divided their attention between the screen and the card in some particular moments. Some participants looked at the card repeatedly almost every time they needed to type the target word on the computer. In contrast, some other participants looked at the card only once in order to write the word in the computer.

For example, participant 2 (excerpt 4) and participant 4 (excerpt 5) looked several times at the card with the sentence while typing the target word into the computer.

**Excerpt 4** Participant 2 looks at the card with the sentence several times in order to type the word ‘snylta’ it into the computer.
Excerpt 5 Participant 4 looks at the card with the sentence several times in order to type the word ‘kringfläckande’ into the computer.

4.4 Searching strategies

Two participants expressed that they normally used online translating services as their primary information source. Online translating services are web pages that provide tools to instantly translate a word or paragraph from a certain language to another. The participants who used these services translated often one word in Swedish to one word in Spanish or in English, which was not enough to understand the meaning of the target word. Consequently, these participants used additional strategies in order to get more information, reaching up to eight strategies in the case of one participant and thirteen in the case of the other. Even if these two participants started using translating services, they changed their primary information source to online dictionaries of synonyms as soon as they found one.

In the following examples, the interactions from participant 4 (excerpt 6) and participant 2 (excerpt 7) searching for the meaning of a target word show that the information from online translating services was not enough to understand the word’s meaning, extending their search.

Excerpt 6 Participant 4 searches for the meaning of the word ‘trubbig’ using a translator and then extending his search with different strategies.
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Excerpt 7 Participant 2 searches for the meaning of the word ‘kuckeliku’ using a translator and then extending his search with other strategies.

Two other participants expressed that they normally used online dictionaries of synonyms as their primary information source. This strategy showed often to provide enough information to understand the meaning of pronouns, adverbs, adjectives, conjunctions, prepositions and interjections. For this reason, participants using online dictionary of synonyms needed up to three strategies to find the meaning of a word. The result of the search in a dictionary of synonyms is often given in the form of a list of synonyms.

The following examples show how participant 1 (excerpt 8) and participant 2 (excerpt 9) understand the meaning of a target word using a dictionary of synonyms:

Excerpt 8 Participant 1 shows an understanding of the meaning of the target word ‘allenarådande’ using an online dictionary of synonyms.

Excerpt 9 Participant 2 shows an understanding of the meaning of the target word ‘pang’ using an online dictionary of synonyms.

The results also showed that participants tested changes in the search queries in order to find a more understandable result. These participants experimented with the unknown words,
adding, removing and changing suffixes, prefixes and additional words to look for changes in
the results.

In the examples below, the interactions of participant 4 (excerpt 10) and 2 (excerpt 11)
showed that they experimented with the form of the target word in order to get an
understandable outcome from an online translating service.

Excerpt 10 Participant 4 shows how he changes the word ‘förvärvsarbeta’ in the search field from an online
translator.

Excerpt 11 Participant 2 shows how he changes the target word ‘tundra’ and adds complementary words in the
search field from an online translator.

In some situations participants showed that, through an elaborate search (especially for nouns
and verbs), they could use the search engine as an information source. They searched on the
engine only to read the texts under the results without clicking on links. This strategy often
showed limited information, which was not enough for the participants to elaborate the
meaning of the unknown word. For that reason, this strategy led to complementary steps
making the search longer.

The following examples shows participant 2 (excerpt 12) and participant 4 found scarce
information about the target word in the results of the search engine, which led to
complementary steps.

Excerpt 12 Participant 2 shows how he read information in the search engine results in order to understand the
target word ‘kuckeliku’. 

12
Participant 4 shows how he read information in the search engine results in order to understand the target word ‘finemang’.

On the contrary, in other situations participants used the search engine as a hub to reach other pages through an elaborate search (especially for nouns and verbs). In these situations participants read the information from the search engine’s results in order to choose a page that could show an elaborate meaning of the unknown word. This way, participants could enter an appropriate page to achieve the elaboration of the unknown word.

In the following examples, participant 1 (excerpt 14) and 3 (excerpt 15) found an elaborate meaning of the target word by using a search engine as a hub in order to reach an adequate page:

Excerpt 13 Participant 4 shows how he read information in the search engine results in order to understand the target word ‘finemang’.

Excerpt 14 Participant 1 shows how he enters a link in the search engine’s results to search for information about the target word ‘tundra’.

Excerpt 15 Participant 3 shows how he enters a link in the search engine’s results to search for information about the target word ‘rationalisera’.
5 Discussion

Before discussing the results of the study, this chapter opens with a discussion on the criteria of the participant’s sample, which is potential threat to the study’s validity.

5.1 On validity

The use of a convenience sampling, the quantity of participants and the homogenization of the sample in this pilot study gave a scarce amount of data from a not representative population. For this reason, the data analyzed in this study do not support the generalization of the study’s conclusions to the whole population. But, since this is a qualitative study, the aim of the sample criteria was not to generalize the conclusions, but to get information-rich cases. Furthermore, since this is a pilot study, the generalization of the conclusions to the population is not as relevant as the viability and adequacy of the method.

The use of alternative target words in each test and a different background for one participant imply the use of unique tests for each participant. This test uniqueness gives variation to the data and contributes to outline an in-depth and holistic portray of the phenomena. Besides this, the variation of the tests provides credibility to the triangulation between sources. Conversely, the differences between participant’s tests make the generalization of the results in between participants at least arguable. Since the generalization of case studies demands a big discussion and the purpose of this study is not to generalize the outcome, the results of the study are not generalized in any way.

5.2 On the findings

The discussion on the findings of the study is framed by the interaction hypothesis (IH), which sustains that the interaction with the environment contains the necessary scaffolds for a learner to acquire an L2. More precisely, these scaffolds deal with the exposure to comprehensible input and; the use of the L2 as an output in interaction with another agent. As computers are part of the environment and since they have interactive capabilities, they are a means to offer a learner scaffolds to elicit SLA. For this study, which focuses on L2 word acquisition, it is interesting to know how the interaction with a computer prevent the user from or let her take advantage of these scaffolds, improving or limiting L2 word acquisition. That is why a detailed account on the human–computer interaction (HCI) when these scaffolds are present shows how HCI improves or obstructs L2 word acquisition for the specific learner.

The results show that a computer improves L2 noun acquisition when the meaning of this specific kind of words is elaborated using images. The interaction hypothesis states that one way to acquire an L2 is the exposure to comprehensible input. A computer scaffolds L2 noun acquisition by providing the learner with the word’s meaning, which makes the noun comprehensible. The meaning of a noun can be provided by the computer in two ways, information from different texts through an elaborate search, or the use of images. The information from an elaborate search is likely to exceed the phonological loop’s capacity with the irrelevant information found between sources. The excess of information produces a bottleneck in the phonological loop which obstructs the storing of this information in the LTS. On the contrary, images convey enough information to elaborate the meaning of a noun without exceeding the capacity of the visuospatial sketchpad (three objects). This fact makes
images more likely to help store the information about a noun in the LTS than the written information from an elaborate search. However, the results also show that computers limit L2 word acquisition when learners use the cut and paste function to avoid typing the target word in each search. The interaction hypothesis states that one way to acquire an L2 is by using this language, and one way of using it is writing. As learners search for the meaning of a new word, a computer scaffolds acquisition by giving the learner opportunities to write the new word in each search. This way, the computer elicits the spacing and/or generation effects, strengthening the storing of the new word in LTS. But when learners cut and paste the words instead of typing them, they prevent both generation and spacing effects from happening. For this reason using these off-loading strategies complicates the storing of new words in LTS.

The use of computers also seems to limit the acquisition of L2 words when learners divide their attention between the screen and the printed word in order to type it. Again, the interaction hypothesis states that one way to acquire an L2 is by using this language, and one way of using it is writing. As learners search for the meaning of a word, computers scaffold L2 word acquisition by giving the learner opportunities to type words in the L2 on the screen. This action can elicit the generation and/or spacing effect, which strengthens the words’ storage in LTS. But when a learner looks at the printed word several times in order to type it, he is off-loading the rehearsal of the spelling of the word to the card. This way the learner is preventing the generation and/or the spacing effect from happening, obstructing at the same time the storing of the spelling of the word in LTS.

The use of computers limits the acquisition of L2 words when learners use a translating service as information source. The interaction hypothesis states that one way to acquire an L2 is by the exposure of the learner to comprehensible input. A computer scaffolds L2 word acquisition through making an unknown word comprehensible by providing the learner with information about the word’s meaning. This information is available in different representation forms such as translations, synonyms, descriptions, images, charts and/or examples. The use of translating services limits the information provided by the computer in two ways: first, it limits the representation forms of the information exclusively to translations, and, second, it limits the output of the search to only one word. In other words, the information obtained by a translating service is often not enough to achieve the elaboration of an unknown word, which leads to an elaborate search. The information from an elaborate search is likely to exceed the phonological loop’s capacity with the irrelevant information found between sources. The excess of information produces a bottleneck in the phonological loop, which obstructs the storing of this information in the LTS.

The use of computers seems to improve L2 word acquisition when learners use a dictionary of synonyms as information source. According to the interaction hypothesis an L2 can be acquired through the exposure to comprehensible input. A computer scaffolds L2 acquisition through making an unknown word comprehensible by providing information about the word’s meaning. As in the previous result, the use of dictionaries of synonyms limits the results of a search to only synonyms. Unlike translators, the outcome of a dictionary of synonyms is always a list of synonyms. This list of synonyms often contains several words, which is often enough to achieve the elaboration of the unknown word. The words on the list are often different in form and sound which enhances their storing in the phonological loop. Furthermore, each word listed in the results of a search in a dictionary of synonyms has a meaning relation to the other listed words, which enhances the storing of the whole synonyms
list in both the phonological loop and the LTS. Thus, the use of dictionaries of synonyms enhances not only the acquisition of the meaning of a new word but each word in the list of synonyms.

The use of computers seemingly limits L2 word acquisition when learners add, remove and change suffixes and prefixes in the unknown word to generate new queries. Regarding the interaction hypothesis, one way of learning an L2 is using this language in written form. As learners search for the meaning of a new word, the computer scaffolds learning by giving the learners the opportunity to type the word in the computer. This activity elicits the spacing and/or generation effect which strengthens the storing of the spelling of the word in the LTS. Each time a learner adds, removes and/or changes suffixes, prefixes or additional words to an unknown word to generate new queries, they generate a series of words similar to the original one. This way the phonological loop, which is disposed to discard similar items series, is more likely to discard the unknown word obstructing L2 word acquisition.

To use the internet search engine as an information source limits L2 word acquisition of nouns and verbs. As the interaction hypothesis leads, in order to acquire an L2, a learner must be exposed to comprehensible input. A computer scaffolds L2 word acquisition through making an unknown word comprehensible by providing the learner with information about the word’s meaning. The information in the results of a search engine is often not enough to elaborate the meaning of nouns and verbs, leading learners to make an elaborate search. The information from an elaborate search is likely to exceed the phonological loop’s capacity with the irrelevant information found between sources. The excess of information produces a bottleneck in the phonological loop which obstructs the storing of this information in the LTS.

6 Conclusions

The present research project is especially interesting because it focuses on how the interaction with a computer scaffolds L2 word acquisition and there is not much research in the area. This pilot study gives an answer to the question: How does human–computer interaction improve and limit Swedish as a second language word acquisition? The results suggest that:

- The use of images can improve the acquisition of nouns in an L2.
- The off-loading strategies to avoid writing an unknown word can limit L2 word acquisition.
- The continuous division of the attention between a printed word and the spelling of a new word on a computer screen can limit L2 word acquisition.
- The use of online translating services as a source of information can limit L2 word acquisition.
- The use of dictionaries of synonyms as a source of information can improve L2 word acquisition.
- Adding, removing and changing suffixes and prefixes in the unknown word to generate new queries can limit L2 word acquisition.
- The use of the search engine results as an information source can limit L2 word acquisition of nouns and verbs.
These results are preliminary since the present study is limited and has only examined how four Peruvians living in Sweden use computers when learning new words in Swedish.

7 Future research

The first and most obvious follow-up question is if this method could work on a greater scale. Moreover, this pilot study showed that an image in some cases could be more efficient to explain the meaning of a noun than an extended text. It could be interesting to continue researching if images are generally more efficient to explain the meaning of nouns. Furthermore, the research showed that an extended text was the only way to understand the meaning of a verb. It could be interesting to study if verbs, like nouns, could also be understood more efficiently with images.
8 References


Human–computer interaction in second language word acquisition


## ATTACHMENTS

**ATTACHMENT 1**

**Table with the list of unknown words and their properties**

<table>
<thead>
<tr>
<th>Word group</th>
<th>Word number</th>
<th>Word</th>
<th>2 Part of the speech</th>
<th>4 Length</th>
<th>7 Polysemy</th>
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<td>noun</td>
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<td>47</td>
<td>luckeliku</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
List with sentences used in the research

1 I nätet låg en brugd.
2 Tundran finns i norra delar av Sverige.
3 Texten är fylld med olika anspråk.
4 Där finns en snabb tornseglare.
5 Etablissemanget står inte över samhället.
6 Anna är en galenpanna och det är ingen nyhet.
7 Sandra fick en aha-upplevelse precis innan jul.
8 Christian lever på existensminimum men han är glad i alla fall.
9 Undantagstillståndet i Etiopien gällde i sex månader.
10 Hurudan typ av person är du?
11 Färre i kön till läkaren.
12 På somliga platser spelar mer fotboll än andra.
13 Handlar det om studier, arbete eller ingendera?
14 Vareviga söndag kan du sova mer.
15 Du kan göra bådadera.
16 Det är vanligt att snylta mat i Peru.
17 Vad händer om jag verbaliserar mina känslor?
18 De inkvarterades hemma hos en kompis.
19 Hon började förvärvsarbetsa.
20 En institution kulturminnesmärker mitt hus.
21 Alla vinner när man rationaliserar soporna.
22 Peter omorganiserar sitt hus.
23 Korruption finns allestädas!
24 Hon dricker mestadels vin.
25 Därpå kysste han henne.
26 Hon tappade emellertid plånboken på platsen.
27 Viktoria är förhållandevis stark.
28 Använd en trubbig kniv!
29 De kan leva i en yvig päls.
30 Den urnordiska texten hade trettiobokstäver.
31 Allehanda skor skulle fungera bra.
32 Den beklämnande fiskeresan slutade bra.
33 Ett kringflackande liv skulle vara jobbigt.
34 Den allnarådande färgen är grå.
35 Klänningen är i alla fall inte iögonfallande.
36 Därtill kom han och bad om ursäkt.
37 Bussen går dock inte klockan fyra.
38 Susi stannade inte hemma, ty hennes barn hade basketbollmatch.
39 Klassikerna låg jämte några nya noveller.
40 De lever på stranden hitom.
41 Det gick igenom linjen.
42 Beträffande väder, är det soligt.
43 Angående maten så kan du köpa pizza.
44 Efter beslutet skrek han Finemang!
45 Det var en pang-grej!
46 Mannen kom för att säga farväl.
47 Kuckeliku hördes långt borta.
### ATTACHMENT 3

**List of the different themes and sub-themes assigned to the expressions in the transcription**

<table>
<thead>
<tr>
<th>theme</th>
<th>sub-theme</th>
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- skill
- strategy
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- test effects