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Information processing theory and comprehension model in language learning: Experiences from future language teachers: a self-study research

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Abstract

The objective of this research is to understand how the Information Processing Theory proposed by Atkinson and Shiffrin (1968) and the Language Comprehension Model proposed by Anderson (1995) affect language learning. The purpose of this paper is to identify the problems that the participants experienced during their language classes regarding retrieval of information, and comprehension issues presented in different language skills. The participants of this longitudinal self-study research project carried out over eight months are two students in a BA in English language teaching at the University of Guanajuato. The students were enrolled in foreign language learning classes; Japanese, French, and Sign Mexican language. Data were collected in a Sway portfolio, using reflective journal entries and visual evidence. The collected data presents results showing that receiving a different set of instructions affects the performance of holding information and the capacity to retrieve it back from the mental system. The analysis also shows that slow recognition of words in regard to listening and reading skills hinder language comprehension. This study has implications for language teaching in terms of bringing awareness of the cognitive mental processes that students go through when learning a language. Stimulating each stage of the models presented in this paper may increase the chances of success in the language.

Keywords: self-study, language learning, information processing, sensory memory, working memory, long-term memory, language comprehension, perception, parsing, utilization, capacity.

Introduction

This self-study research focuses on presenting the challenges faced by future language teachers, heading the role of learners of a foreign language. For this study, each of our participants has accomplished over eight months of studying a foreign language. One of the participants studied Japanese and the other studied French and Mexican Sign Language simultaneously. For the purposes of this study, each of the researchers has explored the benefits of being a language learner. This experience will enable them to better understand the language learning process and prepare for their future careers as language teachers. As a result, this learning experience will allow them to execute all the theories discussed in class in a practical way. This article presents the role of information processing theory as well as the model of comprehension. In this study, both theories focus on the study of a language. It also presents how both models affect language learning and the repercussions that these results can cause in using the target language. On the other hand, the study presents the instruments used by the participants for data collection. Finally, some of the results obtained by each of the participants in their experience as foreign language learners are presented as well. These results are closely related to the theories presented above.

Literature review

The information processing model

It is necessary to define the parts of the brain in charge of processing all the information at the moment of learning a language. Huitt (2003) found “The Information Processing approach focuses on the study of the structure and function of mental processing within specific contexts, environments, or ecologies (p. 1)”. The information processing model proposes three stages that focus on how information is stored in memory. Sensory memory, short-term memory, and long-term memory. In the first stage, the brain understands electrical energy taken from environmental sources. “This memory is very short (less than 1/2 second for vision; about 3 seconds for hearing)” (Huitt, 2003, p. 10). To transfer the memory into the next stage, there are two concepts to make it possible: an interesting feature and a known pattern.

When it comes to language learning, there are two crucial stages responsible for receiving these stimuli: sensation and perception (Field, 2003). During the first stage, new information is recognized through hearing. All sounds (new lexical items) that we hear enter through the auditory canal; thus, thanks to this sensation stage, our system can capture them and send them to the main memory. The second stage, short-term memory, is in charge of analyzing the

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information previously received through the sense of hearing. This operation decodes the message of the stimulus learners received and communicates its meaning. In other words, it tells us what the word is and clearly shows us the meaning of each entry.

Furthermore, little by little, with the use of these entries, people will be able to maintain them in long-term memory. Field (2003) tells us that "an important part of the perceptual process is pattern recognition, where the form of a word is matched to a stored representation in our mind" (p. 18). In this way, after receiving the new entry into the system, learners can divide it according to its different characteristics. Then, we can create stronger links between each item with others already known. This connection will improve the use of the new items more quickly and effectively. On the other hand, Atkinson and Shiffrin (1968) suggested that "there are three types of memory stores [...]; sensory storage, short-term storage and long-term storage" (Field, 2003, p. 18). According to Field (2003), "The sensory store held a trace of a stimulus while the stimulus was being matched to a pattern" (p.18).

Field (2003) tells us that humans possess "two separate sensory stores" (p.18). We can do so auditorily "in the form of 'echoes'" (Field, 2003, p. 18) thanks to the speaker's verbal production. This first storage concerning the auditory part is called "echoic memory". Nevertheless, we can also store information in a visual way, thanks to the graphical representation of each lexical entry. This second store is called "iconic memory". It allows us to grasp and memorize new words on the basis of a visual representation. It was suggested that "the iconic traces lasted only about 0.5 seconds, but that the echo graphic traces lasted longer, with a first phase of about 0.25 seconds for pattern recognition" (Field, 2003, p.18).

The second stage, short-term or working memory, is conscious memory. It is created by paying attention to external stimuli or internal thoughts, or both. Initially, the information available in the working memory will last from 15 to 20 seconds, approximately. If the information is repeated, it might be available for 20 minutes. There are also limits to this stage; there are specific numbers of units that an individual can process. It is to be a range of 7 ± 2, or more recently 5 ± 2 units to be remembered. The number might vary from one person to another, as it is recognized that different individuals have distinct mental capabilities. For instance, a person's mental system may be more prompt to analyze information in chunks and not as individual pieces of data. The concept of chunking refers to a specific mental process of organizing or gathering data into units. Huitt (2003) states that "Chunking is a major technique for getting and keeping information in short-term memory" (p. 18).

Long-term memory or unconscious memory is the focus of cognitive psychology. Long-term memory is the figurative section of the brain where "permanent information is stored" (Field, 2003, p. 38). In long-term memory, a human being stores "language competence -including the lexicon and knowledge of the syntactic system" (Field, 2003, p. 38). Field (2003) points out that "LTM would appear to involve multiple memory systems, each with different functions. A distinction is made between declarative memory (for facts and concepts): knowing that, and procedural memory (for skills and processes): knowing how" (p. 38). In the light of the different constituents that conform long-term memory, one can witness its complexity. As a result, only defining long-term memory as the place where permanent information is stored seems to be an oversimplified statement that omits a great deal of information.

The language Comprehension Model

There are other language cognitive models which consider some features of the information-processing model as well. Some of these models try to explain, for example, how learners comprehend language in its spoken or written form. To provide a broader perspective in this paper, the Language Comprehension Model proposed by Anderson (1995) will be taken too as a reference when trying to understand how the incoming information is comprehended. This model not only focuses on what information is stored in the brain, but how learners try to construct understandable input to later use it as a form of output. It is worth mentioning that the importance of this model consists of providing an insight into listening and reading comprehension problems that learners often face inside the language classroom.

Comprehension of language clearly involves the construction of a representation, whether spoken or written language, so memorizing successfully what is comprehended may involve the retrieval of such representations (Zwaan & Radvansky, 1998). In other words, comprehending language is not only about being able to understand spoken and written discourse, but also the capacity to deliver an understandable message to the receptor. The Comprehension Model proposes three stages: perception, parsing, and utilization (Anderson 1995). During the perception phase, "listeners recognize sound categories of the language, pauses and acoustic emphases in the speech they hear and hold these briefly in working memory" (Vandergrift, 2011, p. 456). More specifically, "an individual attends closely to input and the sounds are retained in echoic memory" (Goh, 2000). In the parsing stage, "listeners segment what was retained in the working memory and also begin to activate potential word candidates" (Rost, 2005, as paraphrased in Vandergrift, 2011, p. 457). Further, learners retrieve the potential words from the long-term memory (Vandergrift, 2011). In other words, utterances are segmented according to syntactic structures or cues to meaning to be recombined to create a

meaningful representation of the initial input (Goh, 2000). In the final stage, utilization, "listeners relate the resulting meaningful units to information sources in long-term memory to interpret the intended or implied meanings and create a representation in memory of what they understood" (Vandergrift, 20011, p. 458). In other words, listeners go beyond the linguistic knowledge previously analyzed to match it with their schematic knowledge from their long-term memory to make it more meaningful and respond to what they are being requested to answer (Vandergrift 2011).

Methodology

For this longitudinal research study, the participants involved worked with a qualitative research methodology. For this specific research, language learning incidents were studied in its "natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2011, p. 3). The data obtained from this research study was characterized within the qualitative paradigm. "With qualitative data, one can preserve chronological flow, see which events lead to which consequences, and derive fruitful explanations" (Miles, Huberman & Saldana, 2014, p. 4).

Within the qualitative paradigm, more specifically, we employed self-study research. The study was "self-initiated and self-focused, aimed to understand our teaching and learning practices [...]" (Moorhouse & Tiet, 2021, p. 6). In this study, the aim was to identify, as self-researchers, what we are pursuing to change as teacher practitioners (White & Jarvis, 2019) in order to develop our 'wisdom of practice' (Schulman & Wilson, 2004).

Participants and context

The participants in this study were two foreign language students involved in this research article as well as their university teacher. They were registered as students in the class "Second language learning I and II" (Lengua Extranjera I & II) in the BA program called Licenciatura de la Enseñanza del Inglés, in the División de Ciencias Sociales y Humanidades, del Campus Guanajuato, de la Universidad de Guanajuato. The BA students participating are all enrolled in a four-year program to become English language teachers.

This research took place over a period of eight months while students were studying a foreign language class. Participant number one was learning Japanese, and participant number two was learning French and Mexican sign language. Both participants of this research speak Spanish as their first language and English as their second language. They are considered bilingual speakers (Spanish and English), so their foreign language class was their third or fourth language.

Data collection instruments

In this self-research study, language portfolios of evidence, weekly journal entries, and self-reflective questions were the main instruments used by the participants. Portfolios of evidence refer to "a collection of evidence that is gathered together to show a person's learning journey over time and to demonstrate their abilities" (Butler 2006). To better explain, "Many different kinds of evidence can be used in a portfolio: samples of writing, both finished and unfinished; photographs; videos; research projects; observations and evaluations from mentor teachers; and reflective thinking about all of these." (O'Connor, Sterenberg & Vaughan, 2020, p. 1145).

Significantly, the use of weekly journal entries was highly efficient in the data gathering process. According to Hiemstra (2001), "A learning journal typically is hand-written in a notebook or on a pad of paper as a means for recording thoughts, reflections, feelings, personal opinions, and even hopes or fears during an educational experience" (p. 20). In order to collect data for this study the participants used an electronic portfolio. The purpose of using this tool was to facilitate their data collection in a progressive, systematic, and permanent way.

Finally, weekly reflective questions were implemented to gather information. Reflective questions can be described in terms of "their capacity to stimulate, or arise as the result of deliberation, introspection, and contemplation" (Malthouse et al., 2015). In particular, reflective questions were helpful to promote deeper thinking about the learning practice. Those types of questions "can be formed through variance between formulations and expectations of experience and what is then perceived to have taken place" (Malthouse et al., 2015). For this specific study, reflexive questions were created based on the importance of only some collected data since not all information is question-worthy (Frase & Schwartz, 1995, as paraphrased in Malthouse et al., 2015).

Data analysis

The data was examined under the constant comparison of information. Initially, the research participants read their journals thoroughly to start selecting the topics that appeared the most. After that, the researchers read their journals once again, looking out for the most valuable and salient information regarding their topic of interest. The researchers used some techniques to identify better key content; more specifically, highlighting, re-reading passages from the diary, and categorizing information. The categorization stage was substantial for this study since it allowed the researchers to look for themes, categorize them, and seek similar patterns among them (Barkhuizen, 2013). Finally, the results presented in this article were chosen based on the similarities among the topics of interest for both researchers. Since the categorization stage, findings were compared to be presented in this paper.

Ethical considerations

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Being this a self-study research project, the participants did not sign any consent form or other document attesting to the authorization of other participants, to add their data or personal information. This way, the information used in the study is the same information that each participant obtained from their project during the eight months of foreign language study. According to Article 19 of the Ley General de Protección de Datos Personales en Posesión de Sujetos Obligados (DOF, 2017) "El responsable no deberá obtener y tratar datos personales, a través de medios engañosos o fraudulentos, privilegiando la protección de los intereses del titular y la expectativa razonable de privacidad". Hence, the participants only reserve the names of external participants, such as their teachers and classmates. This regard is made on the basis of protecting the information of the non-researchers who were peers and teachers in the language classes in which the researchers collected their data. Since the concept of self-study "indicates a private study of an individual and emphasizes subjectivity" (Chao, 2018, p. 46), the researchers are aware that the data collection and interpretation are biased by their own beliefs and influenced by their direct experience.

Results and Findings

The data showed two main themes in regard to the research. The first one is related to the information processing model, and how it affects the retention of information when performing tasks inside the language classroom. The second one refers to the problems encountered, specifically in the reading and listening skills. Both themes explained how the participants struggle with holding information, understanding it, and producing it.

Information Processing Model

Students' working memory is operating at full capacity with attempts to process earlier information, and thus it cannot successfully deal with the simple instruction or fact that the teacher now stated. Working memory is altogether too limited to thoroughly process rapidly delivered information (Beitzel, n.d.). Participant number two felt lost and did not know what to do with a considerable amount of information. She does not know where to store it. Not knowing how to handle so much information generated negative emotions which at times affected her learning. These emotions arose due to the desperation of wanting to use the language correctly, but it was not always possible due to the lack of understanding of certain lexical items and grammatical structures. All the mental tiredness learners experience during this learning process affects their emotions which, in turn, can reduce their concentration and willingness to continue learning. Processing too much information so quickly becomes a burden and, to some extent, can make students feel guilty about this fact. They may think that they are not as willing or attentive as they should be in class, when in fact this is not true.

Here is where as a researcher and participant number two, I found the connection between this model and my emotions experienced as a second language learner. Regarding the study of emotions in the field of EFL, this topic has been examined in various forms over the last fifty years (Stock, 2019, p.206). Emotions within the field of general education have been examined (Do & Schaller, 2004, as cited in Stock, 2019, p.206); however, emotions within foreign language learning have been under researched (Méndez López, 2012, as cited in Stock, 2019, p. 206). Méndez López (2012) points out that "we cannot ignore the fact that students' emotions, feelings, and attitudes shape the process of learning a foreign language and help to determine the degree of success students may experience in this process" (as cited in Stock, 2019, p.206). So, the emotions that we as students experience are a key factor for our achievement in the language classroom. On the other hand, the implications of positive emotions and their effect on students learning a foreign language may be significant, as they could be found to facilitate language learning. This suggests that there is a possibility for positive emotions to help students learn or at least to increase the likelihood for learning (Stock, 2019). According to this, participant two states the following:

> "In my French class, I sometimes feel overwhelmed. I feel that I do not have enough time to work on and retain certain information when we already start with new information. In oral languages, as is the case with French, we see vocabulary, we see grammatical structures, we do pronunciation exercises and with all these activities my mind gets tired, and I feel that I cannot process so much information. I believe that I will never be able to learn this language. (P2-J5-March 3,2021).

On the other hand, it seems that teachers lead somehow to saturate students with so much information. They seem to believe that by providing as much information on each topic seen in class it will be enough for students to understand, memorize and use it effectively; however, this is not how it works inside of the brain, or black box. As students, we also need practice time on these teachings. Therefore, teachers need to create a meaningful link between students' first language and the target language. According to this statement, participant number two expressed the following in one of her journals:

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> "In the case of my French classes, I feel that we see too many topics at once or sometimes we go too fast. It has happened to me that as soon as the teacher gives the instructions to do an activity it takes me a little bit to understand them when I already need to be actually solving that activity" (P2-J5-March 1st, 2021.).

Furthermore, sign languages are complex linguistic systems whose organization implies sequentiality, spatiality and simultaneity, characteristics that together are not found in oral languages (Aldrete, 2018, p. 24). The signer is required to use not only the active articulators, but also to use his/her body, make gestures with his face according to what is being expressed and make optimal use of the signing space (Aldrete, 2018). Participant number two expresses the following about her Mexican sign language learning:

> "In my sign language class, we go over a lot of vocabulary. For this, we use different semantic fields separately, such as verbs, weather, greetings, numbers, etc., and I also feel that I cannot process and memorize as many signs as I would like to. Before immersing myself in this world of sign language, I used to believe that this was a universal language, that at no time there were variations of the signs, that all the time we would use as a base the same signs regardless of the city or region where we are, but to my surprise, this language does not work that way because basically it is a language and like all languages, it has exceptions and variations" (P2-J6-March 8,2021).

Finally, our participant two, faced some complications in terms of her ability to write in the target language. In addition, she also shares that this difficulty has generated some sense of frustration and fatigue in her learning process. In one of her e-portfolio journals, she states the following:

> "When it is especially a verb tense, it takes me even longer to understand the order I need to follow in my sentences to make them correct. My major problem with French verb tenses is the endings. Some days, after class, I take a little space to look up information about what I do not understand in class, but to be honest sometimes I get more confused, and I cannot get clear on the use of the language in certain exercises" (P2-J6-March 10,2021).

In summary, then, practice speeds up processing because it automatizes critical skills. In this way, our participant highlights the importance of repetition and practice of the target language in each of the different language skills. She understands that this process is gradual and it is completely normal to memorize new information little by little.

The comprehension model

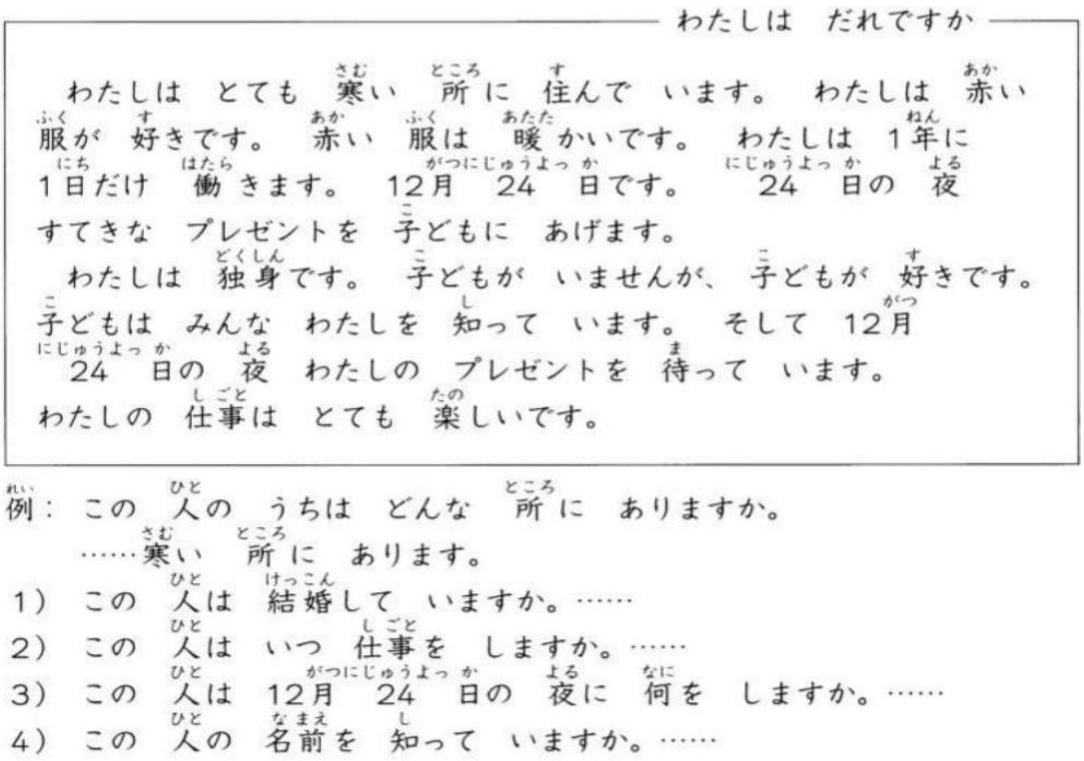
The data obtained during this study revealed some important discoveries regarding the stages of the comprehension model, specifically in the reading and listening skills.

Reading

As mentioned before, the language comprehension model can be applied within different language skills. Two main findings regarding reading comprehension were discovered. Participant one states the following:

> "I had to answer some questions. I did not achieve the learning goal of this activity which was reading comprehension. I had to read more than three times to even understand what the text was about. I was still trying to read the hiragana and katakana (because I haven't learned all of them) and I didn't pay attention to the message itself" (P1-J-March 16, 2021).

The first finding relates to the recognition of written forms. In this excerpt, it can be noticed that Participant number one has not mastered Hiragana and Katakana completely. Hence, it caused a delay in understanding the intended message of the text since the participant had to read the text several times. As the reading skill involves the recognition of written forms (Nation, 2009), the participant had problems in the perception stage because it was difficult to decode the message. The second finding shows that participant one had difficulties when performing two tasks at once. On one hand, the participant was trying to recognize Hiragana and Katakana script. On the other hand, she was trying to understand what the text was about. Performing various tasks simultaneously was distracting the participant of the main purpose of the activity. As a consequence, she could not retain much information from the text as there was too much going on that reading comprehension could not be achieved efficiently.



わたしは　だれですか

わたしは　とても　寒い　所に　住んで　います。　わたしは　赤い
服が　好きです。　赤い　服は　暖かいです。　わたしは　1年に
1日だけ　働きます。　12月　24　日です。　24　日の　夜
すてきな　プレゼントを　子どもに　あげます。
わたしは　独身です。　子どもが　いませんが、　子どもが　好きです。
子どもは　みんな　わたしを　知って　います。　そして　12月
24　日の　夜　わたしの　プレゼントを　待って　います。
わたしの　仕事は　とても　楽しいです。

例：　この　人の　うちは　どんな　所に　ありますか。
……寒い　所に　あります。
1）　この　人は　結婚して　いますか。……
2）　この　人は　いつ　仕事を　しますか。……
3）　この　人は　12月　24　日の　夜に　何を　しますか。……
4）　この　人の　名前を　知って　いますか。……

Image 1: Example of a reading comprehension activity (P1-J-March 16, 2021)

Listening

For participant one, it was found that during all her language classes it was highly challenging to understand the teacher's spoken discourse as well as performing listening activities during the sessions. Essentially, one of the reasons behind language comprehension problems in listening is the slow recognition of sounds and words. It was discovered that participant number one was unable to follow the rhythm and pace the language has. As she had not been exposed to Japanese spoken discourse prior to the language class itself, it was not possible to match the sounds she heard with any kind of information regarding the phonology of the language.

The following excerpts from participant one support the statement above:

> "My professor introduced himself, but... oh lord!!! He speaks really fast! Most of the time, he speaks in pure Japanese and little Spanish remains. I was shocked because, to be honest, I couldn't understand almost anything". "It is really difficult to get used to the Japanese sounds. It is even more difficult to do it when I have never encountered this language before in my life. The sounds are really strange to me because Spanish and English sound completely different" (P1-J1- February 2, 2021).

To continue, some issues in regard to the parsing stage of the comprehension model were found too. She states the following in one of her journals:

> "Yes, I have noticed it. When I face some situations in which I don't recognize a word, it is difficult for me to understand the rest after that unknown word. I tend to pay more attention to deciphering the meaning of the word, and I stop listening to the rest of the information. Sometimes I succeed in finding the meaning, but on some other occasions I fail" (P1-J4-n.d.).

As participant one was focusing on one word only, she stopped listening to the rest of the incoming information. Consequently, the participant was not able to create a clear idea in terms of understanding the message. Besides, she expresses the difficulties of maintaining both tasks active, deciphering word meaning and understanding subsequent input. To better explain, the information in the perception stage is constantly replaced by new information; therefore, the perception stage is affected. Because there was no connection between the two stages, the information vanished quickly from both. As the information in the perception stage is constantly replaced by new information, the parsing step was affected. In summary, Participant one was trying to store one part of the input while simultaneously attending to the acoustic signals for the next part (Goh, 2000). In this sense, overlapping of information (Anderson, 1995) from both stages blocked the information flow from one stage to the other.

Moreover, in the last stage of the model participant one experienced difficulties in terms of understanding what the speaker was saying, and how to answer the speaker's message. The excerpt below shows:

> "I started the exam pretty well, but when the sensei asked me a question I didn't understand what he was asking me to answer. I told him to repeat the question again but still, I wasn't able to answer. I could recognize the words in the utterance, and their meanings. However, I still didn't get the message. I didn't know how to answer that question even though I recognized all the words" (P1-J- May 6th, 2021).

Despite the fact the participant was able to recognize the meaning of each word, it is quite evident that she struggled with understanding the complete message in terms of inferred meaning. Because the participant states that she recognized the words, it can be inferred that she identified words that are familiar with her language repertoire. Nevertheless, being familiar with vocabulary is not enough if those are not key or content words (Goh, 2000). In addition, the participant points out that she could not give a response to the speaker. Given that she did not comprehend the message nor understand the idea behind it, a certain block occurred in the speech of participant number one. The utilization stage is the final step in order to create understandable output. However, the participant could not deliver a message, so spoken communication was interrupted.

Conclusion

This self-study research project examined the language learning experiences lived by two students in a BA in English as a Second Language program at the University of Guanajuato in Mexico. The participants provided a meaningful insight in regard to processing information as well as comprehending language. It became evident that the author's main motivation to abridge the models' description is to make it more understandable to the people interested in it. Nevertheless, the way in which they present the model is not optimal as it can mislead people to think that the stages of both models always occur in the same linear manner. It is worth mentioning that in real situations, each part of both processes can occur in a different order depending on the information that a person encounters.

Another critical point is that it is nearly impossible to isolate the processing of information to only one area of the brain at the time, since processing information is a complex mechanism that requires the constant flow of information among the three memories. Equally important, language comprehension is a process that requires constructing meaning since the first stage of the model. Difficulties within the stages lead to different problems regarding language skills.

The findings presented in this paper have some valuable implications for language teaching, and language learning. For example, educators can design activities that take into consideration the advantages of both models; information processing, and language comprehension in any of the skills. It has been observed that if the information in the environment travels in more than one sensory channel, there are greater chances that learners can process data more effectively. Consequently, learners could improve their comprehension, which in turn can translate into more language learning. Nevertheless, more research is needed to discover why students face difficulties during the language learning process. Equally important, the participants of this study provided a deep reflection about teaching practice. This experience prepares the participants to be aware of some of the issues that arise at the time of teaching within this field of language.

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