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Understanding Cognitive Language Learning Strategies

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Abstract

Over time, definitions and taxonomies of language learning strategies have been critically examined. This article defines and classifies cognitive language learning strategies on a more grounded basis. Language learning is a macro-process for which the general hypotheses of information processing are valid. Cognitive strategies are represented by the pillars underlying the encoding, storage and retrieval of information. In order to understand the processes taking place on these three dimensions, a functional model was elaborated from multiple theoretical contributions and previous models: the Smart Processing Model. This model operates with linguistic inputs as well as with any other kind of information. It helps to illustrate the stages, relations, modules and processes that occur during the flow of information. This theoretical advance is a core element to classify cognitive strategies. Contributions from cognitive neuroscience have also been considered to establish the proposed classification which consists of five categories. Each of these categories has a different predominant function: classification, preparation, association, elaboration and transfer-practice. This better founded taxonomy opens the doors to potential studies that would allow a better understanding of the interdisciplinary complexity of language learning. Pedagogical and methodological implications are also discussed.

Keywords: cognitive processes, cognitive neuroscience, information processing, second and foreign language acquisition, Smart Processing Model

1. Introduction

Generally speaking, it can be said that there are two widespread ways of classifying language learning strategies: by skills and by functions. In the first one, strategies are organized depending on their role within the four macro-skills (oral and written comprehension and expression) and on their application in these four areas: vocabulary, grammatical and translation strategies; see Cohen, Oxford and Chi (2002), and Cohen and Oxford (2002). The second kind of classification organizes strategies according to their function. Under this line, one of the first and most significant classifications related to cognition came from Rubin (1989), who organized it according to the stages he considered necessary in the information processing for cognitive learning: getting process (clarification/verification, guessing/inductive, deductive, and resourcing strategies), storing process (memorization strategies) and retrieval, and using process (practice, monitoring and social strategies). Oxford (1990) and O'Malley and Chamot (1990) took some contributions from the works of Rubin (1975, 1981, 1989) regarding this subject, among others, and made progress in theoretical proposals and classifications. Rose (2012) pointed out that the more widespread classification in research was the classification system proposed by Oxford (1990), who organized strategies into two large groups: direct strategies (those directly involved in manipulating the language and in activating mental processes) and indirect strategies (those which frame and play a supportive role in learning.) These groups include six categories: memory strategies (which relate to how students remember language), cognitive strategies (which relate to how students acquire knowledge about language), compensation strategies, metacognitive strategies, affective strategies and social strategies. On the other hand, O'Malley and Chamot (1990) consider three categories: metacognitive, cognitive and socio-affective, with great similarities to the previous classification.

In spite of their relevant contributions in the field of language learning, these classifications have faced criticism (Dörnyei, 2005; Rose, 2012). This is mainly due to a questionable theoretical basis or to the lack of specificity of the definitions involved. In fact, Rose (2012) summarized that "language learning strategy classification systems have been subject to growing criticism regarding definitional fuzziness and invalid research instruments" (p. 94).

The aim of this article is to define and classify cognitive language learning strategies with a more grounded basis. For this purpose, contributions of previous models, concepts and studies that provide a better perspective of information processing have been examined. Understanding how information flows during processing and the relationships among the involved components is a key factor to the objectives of this study.

2. Review of literature

Hymes (1966) was the first one to use the term *communicative competence*, described as the ability to produce statements that are not only grammatically correct but also socially appropriate. This definition was reformulated by Canale and Swain (1980) and Canale (1983a, 1983b) in an explanatory model of communicative competence that includes four competences: grammatical, sociolinguistic, discourse and strategic. On this basis, I suggest *communicative competence* should be considered as someone's potential to undertake communicative activities in an effective and appropriate way, in different contexts under diverse external demands. It is accepted that external demands determine the internal structure of the competence (which is flexible and systemic) within a context, and that it is built through an integration of three main elements: knowledge, skills (cognitive and practical) and attitudes (Organisation for Economic Co-operation and Development, 2002). These components combine in four *subcompetences* which constitute the communicative competence model adopted in this paper: linguistic, sociolinguistic, pragmatic and strategic. The first three were adopted from Council of Europe (2002), where they were referred to as *competences*. I prefer to consider them as *subcompetences* because, in in different contexts under diverse external demands, communicative activities cannot be executed in an effective and appropriate way without involving all of them. The functional structure of the strategic subcompetence that I suggest would be organized as follows. A metastrategic control is constituted by metaknowledge —conceptualized by Flavell (1979)— plus a regulation system. The latter is in charge of the selection, planning, evaluation and adjustment of cognitive, affective, and communicative strategies to have an impact on language use and learning. As Di Carlo (2016) stated, strategies are those actions defined by their efficiency and efficacy. Metaknowledge includes several types of knowledge (Oxford, 2013): personal knowledge, task knowledge, whole-process knowledge, and strategy knowledge.

Cognition is a word that comes from the Latin term *cognitĭo,-ōnis* (knowledge) and *Longman Concise English Dictionary* (1985) defines it as "the act or process of knowing that involves the processing of information and includes perception, awareness and judgment" (p. 267). Knowing is the human potential of understanding a certain reality and of establishing relations through mental processes and abilities whose individual product is knowledge. Consequently, cognition refers to the mental processes and abilities involved in the processing and validation of information (such as perception, memory, imagination, intelligence and reasoning, among others), which are not emotional or affective.

Humans have a cognitive system that allows them to constantly process information while interacting with the environment. No matter the activity they undertake, there will be a flow of information that could cause the development of skills and attitudes and/or the building of knowledge schemes. In fact, as Grenfell and Harris (1999) stated: "Knowledge in this sense is *information* to be processed" (p. 42).

Language is not an ability that can be thought of as independent from other areas of human cognitive abilities, since the principles that characterize language could be used to explain the nature of any other cognitive ability of human beings, such as conceptualization, reasoning, problem solving, and decision making, among others. This hypothesis is valid because of two main reasons. First, because general cognitive principles describe the domain-general learning. Second, although it is true that some areas predominate in the determination of certain activities or processes, the central nervous system does not operate with self-contained or isolated modules, but in a distributive and interrelated way in the brain (Herrera Jiménez, 2007; Hopper, 2015). Thus, L2 learning would be a macro-process based on the general principles of cognition, for which theories of information processing applied to contextualized data are still valid. Furthermore, it is an integration of diverse processes through which *knowledge* is built and *skills* and *attitudes* are developed. All of these three factors are equally necessary to expand the communicative competence. The learning processes imply flows of information through the cognitive system. This is the main reason why it is useful to understand how they occur and what elements that take part in them. From an explanatory model of information processing, one can infer what the circulation of information is like, what modules operate and to what degree they do it, according to different circumstances and activities. Here lies the interest in cognitive strategies that are used to optimize the mechanisms involved in second language learning.

According to Ellis, "Cognitive strategies are those that are involved in the analysis, synthesis, or transformation of learning materials" (Ellis, 1997, p. 77). O'Malley and Chamot (1990) stated that this type of strategies works directly in the input information manipulating it in various ways to improve knowledge, for instance, practice, organization, inference, synthesis, deduction, use of visual images, transference and elaboration. Dörnyei (2005) considered the contributions made by Oxford (1990) and by O'Malley and Chamot (1990), and stated that cognitive strategies are those which imply the manipulation and transformation of the learning materials/input. Oxford's classification (1990) faced criticism due to the dissociation between memory and cognitive strategies, since memory also implies cognitive processing. This led her to include the memory strategies within the cognitive strategies and after successive reformulations, Oxford conceived cognitive strategies as those that "aid the learner in putting together, consolidating, elaborating, and transforming knowledge of the language and culture" (Oxford, 2013, p. 46).

Having considered these contributions, my definition for language learning cognitive strategies is the following: Cognitive strategies are those actions that learners adopt in a conscious (or potentially conscious), relatively controlled and intentional manner, to optimize assimilation, internalization, construction, consolidation and transference of knowledge and language skills. They are represented by the cognitive pillars underlying the three dimensions of information processing: encoding, storage and retrieval. To establish an appropriate classification, it is necessary to know what processes take place in these three stages. My proposal is to build a functional model that can illustrate these processes, the elements involved, and the relationships among them and to get closer to a description of how the processing operates. In order to continue, it is necessary to review briefly the general principles of information processing.

3. General principles about information processing

The cognitive approach in psychology was developed with the intention of finding answers to the limitations of the behavioral approach, in which the cognitive processes were not relevant and were considered only as black boxes responding to stimulus. The interest of the cognitive approach lies precisely in the psychological processes taking place within the mind. One aspect of the cognitive psychology focused on those processes involved in learning. At the same time, significant progress was made in the fields of computer studies and technology. This allowed the emergence of the information processing perspective, which beyond being a unified theory, could be considered as a combination of theories, concepts and theoretical models. Three main theoretical principles underlie this approach.

The first one refers to the analogy between computers and humans, which resemble in the way they process information. The basic operations are similar, almost the same ones for both systems: *decoding*, *coding* and *encoding*. *Decoding* implies entering input and the initial transformation of data. In humans, this stage is carried out by the sensory receptors and it is operated by nerve impulses, while computers operate with digital units (bits) and the peripherals are in charge of the reception. *Coding* refers to the processing itself. In humans, the processing is carried out by millions of neurons and nerve fibers, while in computers this is done by a microprocessor with millions of electronic micro components. *Encoding* has to do with responses. While in humans responses are generated by effectors (locomotor system, articulatory system, etc.), in machines, other peripherals (monitors, speakers, printers, etc.) are the ones in charge of these responses.

The second principle refers to cognitive limitations. There is a general agreement on the idea that the system of human processing has certain limitations which can be, at least, of two types (Villar, 2003): (1) the number of units to be processed is limited and (2) every cognitive activity needs resources that are also limited.

The third principle refers to reductionism and modularity. Every cognitive activity, complex as it may be, is susceptible to being decomposed and reduced to a limited number of processes, components and sequences that constitute an explanatory model. Decomposing any cognitive process or activity brings the possibility of analyzing each one of the parts involved in detail. Even though these models do not exactly replicate the originals, they do represent them and they allow for tests, adjustments and research that contribute significantly to scientific knowledge.

3.1 Previous Models

Probably the first researchers that made a functional contribution to the information processing theory were Atkinson and Shiffrin (1968), with their *modal model of memory*. This model conceives that information is processed by discrete systems of memory with specific functions. The process starts when the environmental input is processed by the sensory registers (auditory, visual, haptic, etc.) and enters the short-term memory. There it is kept temporarily, depending on the diverse control processes, such as rehearsal (repetition), coding (making the information in long-term memory to be easily retrievable), imaging (use of visual images), decisions making, retrieval strategies (e.g. verbal mnemonic), organizational schemes and problem solving techniques (Atkinson & Shiffrin, 1971). While the information is kept in the short-term memory, it is possible that it will be copied in the long-term memory. The information in the long-term memory that is associated with this new information can also be activated and entered into the short-term memory.

Over the following years, as progress was made in certain areas of cognitive psychology, there were different contributions to this model. Gagné and Driscoll (1988) suggested a similar model of processing that included three stages: (1) influx and comprehension of the input information from the environment through the receptors and sensory register, (2) organization and flow of information in short-term and long-term memories, and (3) retrieval of information, elaboration and exteriorization of the responses to the environment through the response generator and the effectors. The novelty of this model was the inclusion of an executive control and of the expectations, both in a parallel and hierarchical operation over the whole process. The executive control represents the metacognitive aspects, that is, planning, evaluation and correction.

4. The Smart Processing Model

The previously mentioned model has limitations to be considered in the linguistic field, for example, because it does not explain how skills are developed or what happens exactly in the process of coding. Even then, it serves as a basis that can be complemented with theoretical contributions and empirical studies. In this article, I present the *Smart Processing Model* (SPM) to illustrate the processes of *encoding, storage* and *retrieval* of information (see Figure 1). I have given it this name since it is an integral part of the triarchic theory of intelligence formulated by Sternberg (1985).

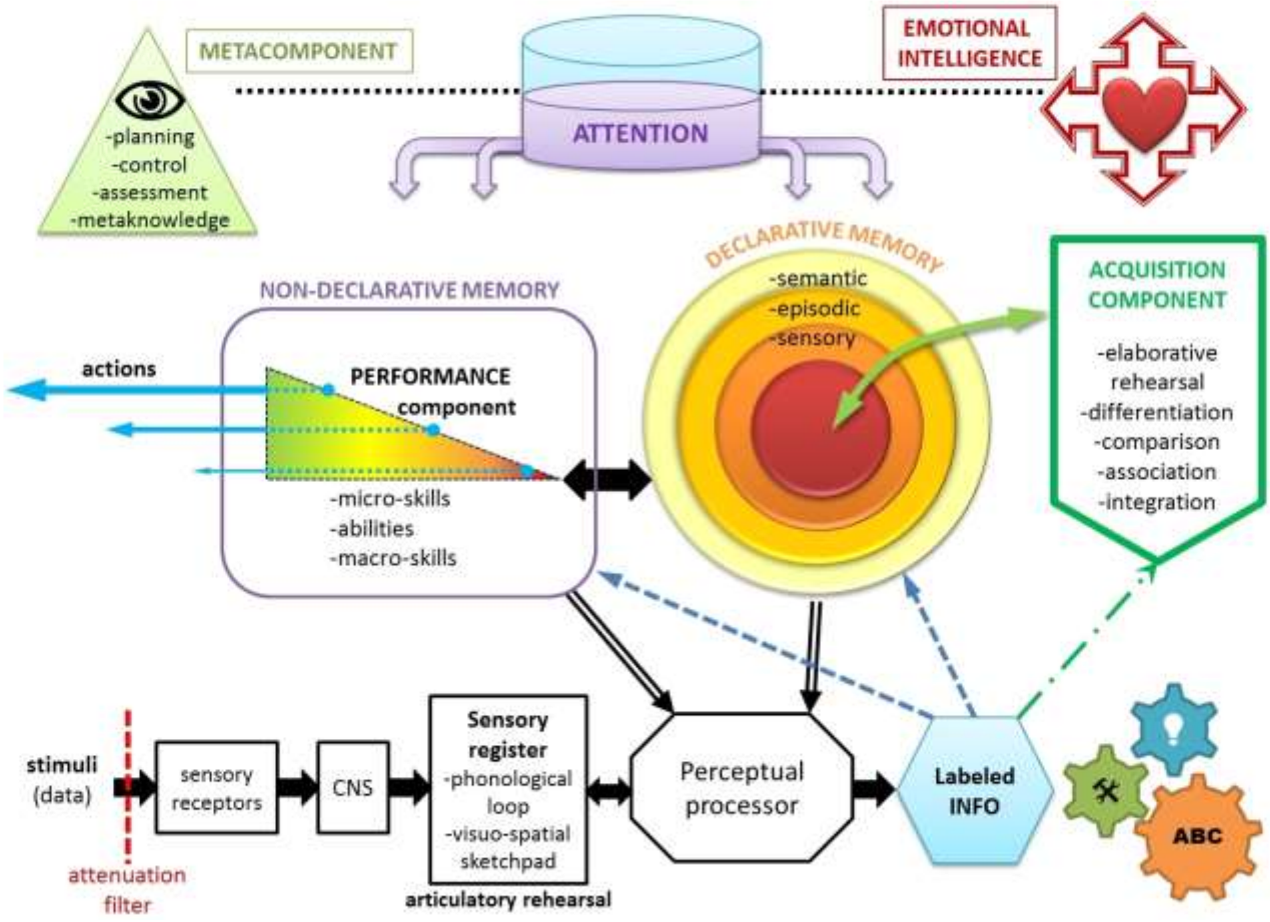

Figure 1. Smart Processing Model (SPM)

4.1 Encoding

All the data coming from outside the body (exteroception) or inside the body (propioceptive or kinesthetic sense), enter the system of processing as stimuli through the sensory receptors (mechanoreceptors, thermoreceptors, nociceptors, photoreceptors and chemoreceptor). These are in charge of receiving and transforming certain physical and chemical variations into nerve impulses that are sent to the corresponding specific zones of the central nervous system (CNS), where they are identified and sent to the sensory register. It should be noted that it is presumed that there exists an attenuation filter of selective attention (Treisman, 1960) which allows weakening or attenuating certain stimuli to give place only to one part of all the existent stimuli.

The sensory register is a system of temporary and ephemeral retention of all sensorial information. It is very limited in the amount of information that it can store as well as for how long this information can be stored. Here we can find the phonological loop and the visuo-spatial sketchpad of the *working memory*, formulated and adjusted by Baddeley (1966, 2000, 2007, 2012). It also takes into account the existence of other slave systems in charge of the data that comes from other perceived sensibilities. The phonological loop is a system that is responsible for the temporal storage and the active maintenance of all that information in the form of sounds or phonemes (verbal). It is made from two components that are responsible for these functions: (1) the phonological store that can retain a few representations (5 to 8 items) over a brief period of time (2 to 4 seconds) (Bruning, Schraw, & Norby, 2012), and (2) the articulatory/subvocal rehearsal that is responsible for retrieving and re-articulating the information of the phonological store, in order to keep it active and prevent its disappearance. Reactivation is a process of articulation, but it does not necessarily imply the production of sound; it can also be done mentally. The linguistic entries in audio enter the phonological store directly, but the other forms enter the store only through a previous coding by the component of the articulatory rehearsal. For instance, the information that is not presented as spoken language (audio), but that it is related to verbal forms, written words for instance, can enter the phonological store through the articulatory rehearsal, which generates the corresponding phonological representation from the linguistic knowledge recovered from the long-term memory (Gathercole, 2008, p. 35) through the perceptual processor. Thus, the phonological loop depends greatly on the linguistic representations in the long-term memory (Baddeley, 2012). Similarly, the visuo-spatial sketchpad is responsible for storing and manipulating the information that can be represented in terms of their visual or spatial characteristics, for example, the mental rotation of an object. According to further studies by Bruning, Schraw, and Norby (2012), the visual registry can retain from 7 to 9 bits of information for about 0.5 seconds.

In the following step, information enters a perceptual processor, which has a dual function: (1) it relates and compares the incoming information with the information already stored in the declarative and non-declarative memories to identify patterns, and (2) based on this contrast, it assigns a specific basic meaning, a kind of tag/label, code and format according to the characteristics found to its future processing. The linguistic units and their constituent elements are perceived as such during this stage, as long as the individual has the characterizing references of the given language.

One of the possible coding would be performed by the independent systems proposed by Paivio (1971): verbal and visual (or iconic). The first one operates with verbal and linguistic information, in which coding is reproduced through a symbolic code. Words and their pronunciations, group of words and sentences would be coded through this system. On the other hand, the visual or iconic system is responsible for the representation of all the non-verbal information through analogous codes, that is, images (including forms, visual characteristics, physical details and physiognomies), sensations and sounds (non-verbal). Although these two systems are independent, information can be coded either in one or both systems, so that they behave complementarily to each other. That is the case of words with concrete referents that are easy to imagine: when they show up, they are coded in a verbal as well as an iconic manner. For example, when an individual sees the written word *tree*, not only its pronunciation and meaning but also the image of the tree are evoked in his or her mind. According to Paivio (1986), this type of words is easier to remember than the abstract or hard-to-imagine words, because they are doubly coded simultaneously.

If a concrete and isolated object is perceived by the visual sensory system, it is transformed into a triggering stimulus. It becomes the epicenter of the activation of a conceptual and image-based network around the assigned meaning of that object. Similarly, when an isolated lexical word is perceived, a semantic field is automatically activated and this will depend exclusively on the previous knowledge of the receiver. These networks activated by whichever stimuli do not only involve concepts but also sensations and mental images, even related connotations and underlying meanings. A smell can produce certain sensations and activate certain thoughts, in the same way that seeing blood, touching a certain surface or listening to a song can become a trigger. In short, multisensory information stimulates the combinations of different proceedings to assign meanings and more complete representations, resulting in a greater capacity for storing and establishing associative links. According to Glasser (1990), we remember 10% of what we read, 20% of what we hear, 30% of what we see, 50% of what we see and listen, 70% of what we discuss, 80% of what we experience personally and 95% of what we teach to others.

4.2 Storage and Retrieval

According to its nature, the labeled information can be sent to the declarative memory, to the non-declarative and/or to the acquisition component. The basis of learning is memory (declarative as well as non-declarative), since it allows for adaptive transformations of the neural substrates to last in time. In fact, every cognitive activity depends on the representations and clues previously built in memory.

Declarative memory (explicit) is the one involved in the deliberate and conscious memories that we have of knowledge and includes semantic and episodic memories (Squire & Shrager, 2008). The *semantic memory* refers to the memory system where all organized background knowledge is mentally represented, except for concrete temporal and spatial personal connections. It includes all the built concepts, relations, rules and schemes. For instance, the knowledge of words and symbolic systems, their meanings and referents, as well as all the linguistic metaknowledge (grammatical, orthographic, discursive, etc.). The *episodic memory* refers to the memory system where all the contextual information of the experienced events is found. It includes everything one can remember about certain events in life, for example, the details of a conversation with a friend, the details of a wedding: the bride's dress, the date, the place, and everything that rebuilds the events. However, the distinction between the semantic and episodic memory is not so rigorous or inflexible, there is a certain underlying interrelation between them. Since the concepts, propositions and schemes are built based on experiences, when it comes to recovering semantic information, it is unlikely that one does not evoke related episodes. Furthermore, it is also necessary to consider the existence of a long-term *sensory memory*, where all the information related to the perceived emotions would be stored, which generally goes hand in hand with the semantic and/or episodic associations. For instance, perceiving the smell of a meal that one's grandmother used to prepare decades ago springs to mind immediately the semantic memories of that grandmother and the episodic memories of the instances of family gatherings. Similarly, I consider that the declarative memory system is not homogeneous, but it would be ordered in different substrates. There would be the more superficial layers, where information has greater probabilities of being lost or deteriorated, and the deeper layers, where information is deep-rooted, consolidated on strong bases, and has a greater quality, and there are less probabilities of loss.

One part of intelligence is the ability to learn, reason and think with new conceptual systems that can be useful later to support existing structures of knowledge (Sternberg, 1990). The *acquisition component* —taken as reference from Sternberg (1985)— is responsible for these processes. In this module, the following activities are performed: (1) selective encoding of new information according to the degree of importance, (2) selective comparison (establishing relationships and comparisons with the previous schemes), and (3) selective combination (integration of the different parts of the information) (Sternberg, 1985). Additionally, in this module the *elaborative rehearsal* takes place. It is defined by Lockhart (2002) as any form of practice that links the information that one wants to remember with the information stored in the mental structure. It consists of elaborating meanings, establishing associations, restructuration and anchorages with the previous schemes of knowledge, which stimulate the retention of information in the deeper levels of the declarative memory. This elaboration is not simply the reprocessing of the same information, but the coding of the same content in different but related ways. The greater the semantic elaboration on the entering information, the better the subsequent recovery will be, since in this way there is a greater number of meaningful propositions and elements available for future reconstructions. Anderson and Reder (1979) named this phenomenon *elaborative processing*. The *acquisition component* integrates the new information in the declarative memory, and it organizes and restructures the knowledge schemes. The ability to face new situations and solve problems depends mainly on this component as well.

Another large component in SPM is the *non-declarative memory* (implicit memory). It refers to the mechanisms that allow the storage and retrieval of information needed for existence and performance of skills and the implicit learning ways, that is, non-associative learning (habits, sensitization, priming) and associative learning (operant and classical conditioning). Although this information is used and retrieved, we do not have reflexive consciousness about it (Sternberg & Sternberg, 2009). The implicit memory seems not to be affected by amnesia (Robbins, 2009; Sternberg & Sternberg, 2009) and can operate in a non-intentional or irreflexive way when it comes to store as well as retrieval. It influences our learned actions, but we are not conscious of it. For example, tying your shoes, playing a piece of music on the piano or completing the missing letters in a word are actions which can be carried out without a reflexive consciousness. In this memory, there is the *performance component* —an adapted component of the triarchic theory of Sternberg (1985)— which executes and performs the actions chosen by the metacomponent.

The most important aspect to highlight for the linguistic area is that in the non-declarative memory there are *skills*: effective forms of acting which can be developed and improved (Ledesma, 1979). They involve content of different types, such as emotional, conceptual, perceptive, muscular, motor, etc., and consist of multiple molecular events and actions (even instinctive, involuntary and out of the reflexive consciousness) that are involved in acting (Villanueva, 2008). A skill is not developed by reading about it or listening to explanations but through practice, in a continuum of execution, correction and improvement. In many skills, mainly those related to language, there is an intimate relation with knowledge in the explicit memory. Linguistic skills (from basic auditory, motor, visual and articulatory to abilities and macro-skills), as well as other types of skills, depend on physical, perceptive-motor and psychophysiological mechanisms available in each person and these can be controlled or automatic operations. The concept of *automatic process* or *automatization* was conceived by Neisser (1967) and reworked by Shiffrin and Schneider (1977), and Neves and Anderson (1981), among others. Controlled operations are relatively slow, sequential, and intentional (with certain effort); they require conscious control and several attention resources. Automatic operations are relatively quick; they can happen in parallel, generally out of reflexive consciousness. They also require less efforts and cognitive resources, such as attention. Controlled processes are generally less practiced activities or require higher levels of cognitive processing due to a lot of present variables (e.g., writing and deep understanding). On the other hand, automatic processes are largely deep-rooted activities, with a high degree of practice which require less cognitive processing (Sternberg & Sternberg, 2009). With the necessary practice and continuity, most cognitive procedures may become completely or partially automatic. Obviously, simple tasks become automatic much more easily than others of greater complexity do. It is true that completely controlled processes and completely automatic processes are the two extremes of a continuum, in which we can find the most of activities and procedures. Summing up, it is generally accepted that: (1) automatic processes require less or no conscious (intentional) attention for their execution; (2) they are only acquired through practice, and (3) they require few cognitive resources (Bruning et al., 2012). For example, in the case of basic readers in a foreign language, they may have difficulties assigning meaning not because they lack understanding skills, but because many of their resources are assigned to word decoding (Stanovich, 2000). Therefore, they will need time and practice to automatize this last process.

The *performance component* determines the ability of automatizing those activities that require known conceptual systems, that is, executing actions with fewer cognitive resources (conscious attention). In order to carry out actions, first, the brain areas involved in the mental processes are activated. If physical actions need to be performed, the nervous central system stimulates the required motor effector (muscular, articulatory) and glandular organs. By *action*, we mean any performance or operation (individual or sequenced methodically) of physical or mental nature that involves an activity, movement or change executed voluntarily by an individual.

Ausubel et al. (1978) highlighted the relevance of practice for every type of learning: In general, complex ideas require subsequent reviews over time to be assimilated in a clear and stable manner, and so they have a transfer value for related ideas. Meaning acquisition and cognitive restructuring take place progressively while interactions with tasks and learning material occur. According to these authors, after the first contact with a certain idea is made, subsequent spaced reviews —which includes multiple exposures, trials and exercise— considerably increase the probabilities of qualitative and quantitative changes in the cognitive structure because previously learnt contents are consolidated.

4.2.1 Operative Units of Cognition

In the explicit memory and in the acquisition component, information becomes *knowledge*. That is, all the information that preexists, that is acquired and on which different mental operations are performed in a way that it can be assimilated, transferable and may become part of other cognitive processes. The elemental units used to produce all types of cognitive operations are basically four: representations, concepts, propositions and schemata. Below, I briefly introduce some considerations on the mechanisms of acquisition and building of these units and their characteristics, since they are the fundamental bases for the storage and retrieval.

Learning *representations* is the most basic type of learning and it happens when different arbitrary symbols match their referents (they can be real objects, concepts, events, etc.) (Ausubel et al., 1978). This is possible due to the existence of a genetic potential in humans that allows for the substitution of real referents for stimulation patterns, generally visual or audible. According to Ausubel et al. (1978), learning vocabulary applies this principle and it would consist of three stages: (1) equivalences between signs and concrete images, (2) equivalences between words that represent general concepts and abstract and categorical contents, and (3) equivalences between words with a higher degree of abstraction and the criteria attributes obtained from explicit contexts or definitions. In the case of learning vocabulary in L2, the learner generally only has to learn the new corresponding sign since the conceptual referent has already been built when learning L1.

Concepts are built with criteria attributes that can be acquired in two ways (Ausubel et al., 1978): through direct, immediate and concrete experience, in successive exposures (formation), or from referents and concepts that already exist in the cognitive structure, not necessarily depending on empirical and concrete support (assimilation).

During formation, cognitive processes take place in this sequence (Ausubel et al., 1978, p. 97): (1) discrimination and analysis of different patterns of sensory stimuli; (2) formulation of hypothesis; (3) confirmation of hypothesis; (4) designation of categories; (5) relation of categories with relevant anchoring ideas in the cognitive structure; (6) differentiation of the new concept from those related and previously acquired ones; (7) generalization of the attributes to all the members of one type; and (8) representation of the new categorical content through a conventional sign.

Other of the operative units of cognition are *propositions*, abstract forms that represent the underlying meaning in a relation between concepts. They have the potential of representing actions, categories, attributes, spatial positions and any type of link. In addition, they can become embedded and interconnected with each other to express more complex meanings. Propositions are not the phrases themselves, but their meanings and they are what lasts in the memory and not the exact form of the phrases (Bruning et al., 2012, p. 51). Learning them includes the ideas underlying the combination of several words. This implies knowing not only the concepts of each word involved but also the evoked, connotative, idiosyncratic and implicit meanings of the combination, requiring several associations with the proper cognitive structure.

The last operative units are the *schemata* (or schemas), mental configurations formed by significant structures of related concepts that serve to organize knowledge. They include information about events or scripts, places, familiar scenes, stories, objects and their relations. Because of them, we can understand what to do and in what order in a certain place, we can establish inferences and, above all, we can learn. They vary in size and abstraction degree and are inclusive, that is, it is possible to find schemes inside other schemes. They are individually built, mainly from experiences and social information, and they are well determined by cultural factors of the environment where the learner is immersed. That is why they are so important in the process of understanding second languages since the competences have to adjust to the contextual situation. That means having a quite complex and accurate scheme of the setting to carry out language activities properly. Schemata activate in specific moments to guide our behavior and also to facilitate assimilation of new knowledge (Bruning et al., 2012). These activations are related to the sensitization of neural networks that when excited, they bring to conscience those representations related to new stimuli. Since the contents in the memory are representations similar to the experiences (not exact copies), the coding and storage vary according to the activated schemes (McVee, Dunsmore, & Gavalek, 2005). For authors such as Craik (2002), Greene (1992) and Mandler (2002), retrieval is a reconstructive process because when information is stored, what is really kept is not every aspect of an event, but only those elements that are considered as key according to previous schemes, that is, the main ideas. Therefore, when information is retrieved, those key elements are resumed and the experience is rebuilt. The reconstruction will vary in quality according to the quantity and accuracy of the traces as well as to previous knowledge. As a result, schemata provide the structures that guide the retrieval process, which implies recreating/rebuilding information and events. Therefore, memory is not as reproductive as it is constructive and reconstructive (Bruning et al., 2012). In addition, in the learning process, schemata are constantly updated with new information. If they are in an orderly fashion (related and hierarchically), there are greater probabilities that contents could be accessed in the long term (Mandler, 2001). In fact, Tulvin and Osler (1968) arrived at the empirical conclusion that the learned contents are retrieved much better when two conditions are given: (1) the information to be processed is organized, and (2) the existing conditions in coding are also present at recalling. This phenomenon known as *encoding specificity* (Tulving & Thomson, 1973) emphasizes the importance of situational context in cognitive processes.

4.3 Global Components

Global components are three: metacomponent, emotional intelligence and attention. They are called this way because they can affect the whole process and/or some of the stages. The *metacomponent* is a complex functional element supported by a body of metaknowledge and formed by a system of higher-order intellectual processes which are in charge of planning, monitoring and comprehensive assessment of the whole process. It takes decisions, identifies problems, chooses actions, strategies and lower-order components, and regulates and evaluates results. The strategic subcompetence would be included in the metacomponent.

Another global component is *emotional intelligence*, which is defined, according to Mayer and Salovey (1990) and Mayer et al. (2000), as the ability of: (1) perceiving, evaluating and expressing emotions in a precise and proper manner, (2) using emotions to facilitate thinking, (3) understanding and analyzing emotions and using emotional knowledge effectively, and (4) regulating our own emotions to foster emotional and intellectual growth. In addition, this component includes motivational and attitudinal factors that influence the learning process in a catalytic and non-specific way to energize it (Ausubel et al., 1978). This means that these variables do not directly affect the cognitive interaction process as the cognitive variables do. The influence of this component is characterized by the impulse and the speeding of the information processing by improving available efforts, attention and willingness to learn (Ausubel et al., 1978). Moreover, emotional factors may cause adverse phenomena, for instance, lack of motivation, initiative, perseverance and control over impulsiveness, fear of failure, excessive dependency, low or excessive commitment, excessive self-confidence or mistrust (De Zubiría, 2006).

The third global component is *attention*: the voluntary involvement in assigning mental energy to doing any intellectual or sensory activity. Attention is the most precious resource of the mind, with the possible exception of knowledge; it is the fuel of mind (Bruning et al., 2012). Every activity carried out in any stage of information processing requires mental energy and, therefore, a certain level of attention. That is why attention is considered a global component. The metacomponent and the emotional intelligence substantially influence the attention availability and the mechanisms that regulate them. For example, great part of the positive effect of motivation in learning is caused by an increase in attention (Ausubel et al., 1978).

In short, the SPM is designed upon the basic aspects and the complementary contributions of different models, theories and researches that provide a more holistic perspective of learning and can be applied to L2 acquisition. It helps to identify stages, relations, modules and processes that occur during the flow of information. For our purpose, we emphasize the coding, storage and retrieval of information. Learning should be considered as a result of the integral action of these three dimensions which operate in an interrelated way. Furthermore, the comprehensive action of all the elements of this model would set the foundations of higher-order human faculties, such as language, critical thinking, problem solving, innovative and creative thinking, decision making, role performance as social and individual agent (competences) and abstraction ability, which is reflected in the potential for simulation and projection to the future.

5. A glance from neuroscience

From a psychobiological perspective, learning is an adaptation of the plastic nervous system as a result of the experiential interaction with the environment. It involves transformations in neural substrates and potentially lasting changes in the individual's behavior. Learning is expressed in the actions of an individual, in which not only do learned contents, but also maturing factors take place. Maturing should be understood as an ontogenic process through which the maximum development is reached. It implies the action of metabolic, hormonal and exercise processes. Thus the environmental adaptation of a person is influenced by ontogenic factors and learned factors which determine the structure and functional regulations of the synapses, that is, the neural plasticity.

Learning a second language is also an adaptation process that leads to brain structure changes. Those changes include increased gray matter density and white matter integrity (Li, Legault, & Litcofsky, 2014). In particular, an association with the increase in the cortical thickness in left inferior frontal gyrus (Klein, Mok, Chen, & Watkins, 2014). Stein, Federspiel, Koenig, Wirth, Strik, Wiest, Brandeis, and Dierks (2012) obtained similar results and added that an increase in grey matter also took place in the left anterior temporal lobe. Along these lines, Mårtensson, Eriksson, Bodammer, Lindgren, Johansson, Nyberg, and Lövdén (2012) concluded that after intensively studying a foreign language, cortical thickness, left superior temporal gyrus and hippocampal volumes increased. Furthermore, learning a second language increases the density of grey matter in the left inferior parietal cortex (Mechelli, Crinion, Noppeney, O'Doherty, Ashburner, Frackowiak, & Price, 2004).

A higher grey matter density implies a larger quantity of synaptic connections, thanks to the neural plasticity. According to Gumá Díaz and Alcaraz Romero (2001), the neural arrangement would generally develop in three stages: (1) synapse constitution in a genetic and natural way in the initial ontogeny of the organism, (2) sufficient syntonizing of synapses, as a product of neural activity and environmental stimulation, and (3) regulation of synaptic efficiency, which depends on life experiences. In the first two stages there is a great growth of synapses as well as great decrease and eventual disappearance of those inactive synapses. Each neuron can connect to hundreds of other neurons through synapses formed by high-density networks arranged in layers in the brain cortex. It is estimated that each neuron of the cortex has 40,000 synaptic connections, and if we consider the approximate total neurons in the cortical layer, the number increases to almost 500 billion synapses (Lamb, 1999). Synaptic connections are not absolutely fixed and unalterable, but they can change their transmission properties, depending on their activities. The more times connections and links are activated in the neural substrates, the stronger they become. Of course that these repeated activations are not random, as Hopper (2015) stated, "it may take many ways and many times of receiving new information for your brain to know that it knows…The brain needs feedback and repetition" (p. 104). This phenomenon is known as consolidation: "Consolidation is taking ownership of new information by allowing time for neuronal pathways to be established" (Hopper, 2015, p. 104). More vigorous and numerous synapses allow for better and easier reconstructions. Therefore, the practice and use of learned contents is essential.

There are certain specific neurons (most of them found in the hippocampus region) which have the property of modifying their connections: the result can be a lasting improvement in the transmission efficacy or a weakening (Ortega Loubon & Franco, 2010). This property is called *homosynaptic plasticity* and involves complex physicochemical mechanisms that cause molecular interactions in the synaptic terminals. The two resulting phenomena are known as long-term potentiation (LTP) and long-term depression (LTD), which have a very important role in learning (Cook & Bliss, 2006). The fact is that a great part of the relatively permanent changes in the synapses do not happen spontaneously, but through processes and stages that are developed over time.

Nevertheless, despite the great complexity of the topic, a simplification could be done to illustrate the main underlying actions. In order to do that, I suggest identifying the procedures and stages that promote the development of longer and more effective neural networks in the transmission. First, it is necessary to *sensitize* the connections and then *syntonize* to initiate the long-term potentiation (LTP). Once the neural clusters or networks are formed, these could *interconnect* with each other through singular unidirectional channels. In addition, the networks could *expand* in every direction (omnidirectional). Moreover, constant activations can *fortify* and keep synapses (regulation of the synaptic efficiency) to improve the efficacy of the transmission. It is worth mentioning then that these five remarked actions contribute to a better joint neural performance and, therefore, we suppose that they also favor learning-performance.

6. A proposed classification for cognitive strategies

Up to now, I have presented a definition of language learning cognitive strategies, a glance into the learning from neuroscience and an explanatory model of the main processes that take place during the encoding, storage and retrieval of information. According to these contributions, I propose a comprehensive classification for language learning cognitive strategies, in which five categories are defined, each of them with predominant functions.

Classification strategies are meant to:

- sensitize existing neural connections and stimulate future synaptic potentiation, and
- discriminate, select and classify (or categorize) information so that it is much simpler, quicker and more organized to carry out subsequent structuring and representation.

Preparation strategies have the following functions:

- establishing new networks of neural connections;
- syntonizing synapses and initiating the long-term potentiation;
- adapting perceptual components and effectors to operate with the new linguistic signs;
- establishing representational, intentional and non-randomized relations between the new signs and the psychological meanings already established in the idiosyncratic structure;
- developing initial auditory, motor, visual and articulatory skills through simple procedures, and
- learning representations and forming concepts.

Association strategies are meant to:

- interconnect neural networks;
- create associations in more particular or more global dimensions, whether they involve new or known contents;
- establish relations, links and comparisons between the new contents and previous schemes (selective comparison), and
- assimilate concepts and learn propositions.

Elaboration strategies help to:

- expand neural networks;
- structure, build and deepen the conceptual units while new information is obtained;
- elaborate or re-elaborate information at a complex semantic level;
- integrate the different parts of information (selective combination);
- formulate hypothesis, and
- organize and restructure knowledge schemes.

Transfer and practice strategies have the following functions:

- fortifying, keeping and reactivating neural connections already formed;
- expanding and transferring the application of knowledge and skills on other more particular or global instances;
- promoting the development of skills, abilities and macro-skills, and
- consolidating associative links.

It is important to mention that this functional classification is not fixed in the sense that it is not meant to encapsulate certain activities or processes in one category or another in an exclusive manner. On the contrary, it is believed that potentially strategic activities have a predominant function, and thus a greater affinity with one or another category. It is rather a classification with dominant nuances, given the complex, combined and interrelated nature of the dimensions involved in the information processing and learning. Hence, the potential strategies may belong to more than one category. For instance, the use of tongue twisters and rhymes can have as its main purpose to prepare the articulatory system for producing a certain sound, but it is also true that it implies practice that strengthens specific neural connections and fosters the development of oral expression in the simplest stages. It is not excluded that saying tongue twisters has additional impacts in associations, classifications and elaborations. Therefore, we could classify it mainly as a potential preparation strategy, but also as a potential practice strategy in a second place and so on.

This criterion is consistent with the approach in neuroscience that considers that every complex brain function is the result of a concerted work from all and each of the different areas and functional brain units (Herrera Jiménez, 2007).

Although there is overwhelming proof that certain cognitive processes are located in specific areas of the brain, this does not mean that all the cognitive functions are separated from each other. In fact, most cognitive psychologists accept that the different brain functions are rather integrated (Hopper, 2015). In this sense, Table 1 shows the components of the SPM and their corresponding cortex areas associated to the predominant functions, according to the sources in Bruning et al. (2012), Squire and Shrager (2008), Orrison (2008) and Lamb (1999). In this way, we can note that different components share cortical areas in an interrelated way.

Table 1. Components of the Smart Processing Model and related cortical areas

SPM components	Cortex areas mainly involved
Metacomponent	frontal lobe (prefrontal cortex-neocortex)
Attention	frontal lobe (prefrontal cortex)
Emotional intelligence	frontal lobe (prefrontal cortex) temporal lobe
Acquisition component	frontal lobe (prefrontal cortex-neocortex) temporal lobe
Explicit memory	frontal lobe temporal lobe
Implicit memory and performance component	frontal lobe (neocortex, Broca's area, premotor area and motor cortex) occipital lobe (visual cortex)
perceptual processor and registry register	parietal lobe occipital lobe

7. Discussion

The aim of this article was to define and classify cognitive language learning strategies with a more grounded basis than that of previous studies on the field. In order to have a better perspective on the issue, I have presented an introductory overview of the classifications of learning strategies and an explanatory framework to locate them in the studies on language. Communicative competence is the potential of a person to communicate in an effective and proper way in different contexts. It includes three factors (knowledge, skills and attitudes) that are integrated in four dimensions or subcompetences. One of them is the strategic subcompetence which includes a metastrategic control and different types of strategies: affective, communicative and cognitive. I have considered that language depends on other mental processes and that the principles that characterize it could be applied to any other cognitive ability. Consequently, learning or using a target language is a macro-process, for which the general tenets of information processing are valid. The multiple subprocesses of learning or using a language imply flows of information through the cognitive system. This is the main reason to consider this relevant to understand how they happen and which the operating components are. Thus, the interest in cognitive strategies that are used to optimize the mechanisms involved in second language learning. In short, what is new about the study is outlined below.

After a conceptual review, I defined cognitive strategies as those used to optimize assimilation, internalization, construction, consolidation and transference of knowledge and language skills. These strategies are represented by the cognitive pillars underlying the three dimensions of information processing: encoding, storage and retrieval. To establish an appropriate classification of cognitive strategies, it was necessary to know in detail those processes taking place in these three dimensions. When reviewing processing models, limitations were found to explain some issues. Hence, the need for building a new model that could overcome previous weaknesses. The result was the Smart Processing Model (SPM), a functional model that helps to better identify the stages and the relations between the involved modules. This model helps to illustrate which are the processes supported by cognitive actions that occur while the information flows. The SPM presents a comprehensive perspective that involves multiple components operating over the actions of processing: perception, attention, memory, metacomponent, emotional intelligence, acquisition, and performance components. In addition, I have theorized what happens with operative units of cognition during learning in order to obtain procedural patterns which contribute to the proposed classification.

Many of the models that explain language use or learning are centered only on the linguistic aspect. However, when it comes to communication, a large number of variables, not only linguistic ones, play an important role. The assignment and transfer of meanings are determined by a multiplicity of circumstantial facts that constitutes *information packages* to be processed. Any linguistic production is not presented isolated but in a temporo-spatial setting that involves a great number of elements. There are also participants (including their characteristics, background knowledge and relationships between them), intentions and objectives. In addition, the verbal element can be accompanied by non-verbal elements, in writing (support, format, typography, images, etc.) as well as speaking (phonic modifiers, sound indicators, gestures, body movement, personal space, etc.). All these *operators* complement the partial meaning of linguistic elements so that the partial meaning can be completed by the learner. The indicators of these variables are perceived and processed together with verbal elements. Hence, it is important to have a global model that operates with linguistic inputs as well as with any other type of information. Moreover, in L2 learning, the expressions of these operators help to form associations among familiar meanings and their corresponding unknown signifiers of L2.

Another contribution to define the categories in the cognitive strategies came from neuroscience. Learning is an adaptation of the plastic nervous system that involves transformations in neural substrates and potentially lasting changes in the person's behavior. Most of these changes are not produced spontaneously but through processes and stages that develop over time. Thus, neural connections can change their signal transmission properties. After raising estimations about how neural networks could expand and improve their transmission, I proposed five actions related to those processes which would also contribute to learning-performance: sensitizing, syntonizing, interconnecting, expanding, and fortifying. These actions were crucial to define the different categories.

Based on the analysis and contributions presented in this article, I have proposed a new functional classification for the cognitive strategies consisting of five categories: classification, preparation, association, elaboration, and transfer-practice. It is assumed that any activity has predominant functions. This classification is not intended to place the strategies in one or another category in an exclusive manner, since there are different and interrelated underlying processes in learning (and in information processing) involving a combined work of all the areas and functional brain units. Previous classifications of cognitive language learning strategies from other authors like O'Malley and Chamot (1990), and Oxford (1990, 2013) were not really supported by a solid theoretical basis that could account for the criteria applied to establish such categorizations. This is a limitation I tried to overcome by justifying the criterion with the description of the underlying cognitive processes that take place during information processing and with contributions coming from the neuroscience approach.

This taxonomy opens the doors to potential studies that would allow a better understanding of the interdisciplinary complexity of learning. Furthermore, it could derive in practical applications, for instance, identifying cognitive strategies and optimizing the development of different specific functions. It remains to be determined in future studies, among other things, whether the defined categories are associated to multiple factors, such as proficiency level, sex or age. These kinds of studies are quite common in the learning strategies field and they would contribute to potential studies that take the learner’s characteristics into account. Summarizing, cognitive language learning strategies have been redefined and it has been possible to establish a classification for them based on stronger foundations, successfully achieving the corresponding objectives. To conclude, it is too soon to confirm the impacts of the proposals in this article and it is necessary to continue working to get a more finished comprehension of the use and the aspects related to the cognitive language learning strategies.

References

Anderson, J. R., & Reder, L. M. (1979). An elaborative processing explanation of depth of processing. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 385–404). Mahwah, NJ: Erlbaum.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (pp. 89–195). New York: Academic Press.

Atkinson, R. C., & Shiffrin, R. M. (1971). *The control processes of short-term memory.* California: Stanford University.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1978). *Educational Psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Baddeley, A. D. (1966). Short-term memory for word sequences as function of acoustic, semantic, and formal similarity. *Quarterly Journal of Experimental Psychology, 18*, 362–365.

Baddeley, A. D. (2000). Short-term and working memory. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 77–92). New York: Oxford University Press.

Baddeley, A. D. (2007). *Working memory, thought, and action*. New York: Oxford University Press.

Baddeley, A. D. (2012). Working Memory: Theories, Models, and Controversies. *Annual Review of Psychology, 63*, 1–29. http://dx.doi.org/10.1146/annurev-psych-120710-100422

Bruning, R. H., Schraw, G. J., & Norby, M. M. (2012). *Cognitive psychology and instruction*. New Jersey: Pearson Prentice Hall.

Canale, M. (1983a). From communicative competence to communicative language pedagogy. *Language and communication*, *1*, 1–47.

Canale, M. (1983b). On some dimensions of language proficiency. In J.W. Oller (Ed.), *Issues in Language Testing Research* (pp. 333–342). Rowley, MA: Newbury House.

Canale, M., & Swain, M. (1980). Theoretical bases of communicative approaches to second language teaching and testing. *Applied linguistics*, *1*, 1–47.

Cohen, A. D., & Oxford, R. L. (2002). Young Learners' Language Strategy Use Survey. In A. D. Cohen & S. J. Weaver (Eds.), *Styles and strategies-based instruction: A teachers' guide* (pp. 75–78). Minneapolis: Center for advanced research on language acquisition, University of Minnesota.

Cohen, A. D., Oxford, R. L. & Chi, J. C. (2002). Language Strategy Use Survey. In A. D. Cohen & S. J. Weaver (Eds.), *Styles and strategies-based instruction: A teachers' guide* (pp. 68–74). Minneapolis: Center for advanced research on language acquisition, University of Minnesota.

Cooke, S. F., & Bliss, T. V. P. (2006). Plasticity in the human central nervous system. *Brain*, *129*(7), 1659–1673.

Council of Europe (2002). *Common European Framework of Reference for Languages: Learning, Teaching, Assessment*. Strasbourg: Cambridge University Press.

Craik, F. I. M. (2002). Levels of processing: Past, present...future? *Memory*, *10*, 305–318.

Di Carlo, S. (2016). A different perspective to define language learning strategies. *International Journal of Research Studies in Language Learning, 6*(4), 43–51. http://dx.doi.org/10.5861/ijrsll.2016.1594

De Zubiría, J. (2006). *Teorías contemporáneas de la inteligencia y la excepcionalidad* [Contemporary theories of intelligence and exceptionality]. Bogotá: Cooperativa Editorial Magisterio.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist*, *34*(10), 906.

Gagné, R.M., & Driscoll, M.P. (1988). *Essentials of learning for instruction.* New Jersey: Prentice Hall.

Gathercole, S. E. (2008). Working memory. In J. H. Byrne, & R. Menzel, *Learning and memory: A comprehensive reference* (pp. 33–51). Oxford: Elsevier.

Glasser, W. (1990). *The quality school: Managing students without coercion*. New York: Harper and Row Publishers.

Greene, R. L. (1992). *Human memory: Paradigms and paradoxes*. Mahwah, NJ: Erlbaum.

Gumá Díaz, E. (2001). La memoria humana. In E. Gumá Díaz, & V. M. Alcaraz Romero (Eds.), *Texto de neurociencias cognitivas* [Text about cognitive neurosciences] (pp. 195–234). Federal Distric: El Manual Moderno.

Hymes, D. H. (1966). Two types of linguistic relativity. In W. Bright (Ed.), *Sociolinguistics* (pp. 114–158). The Hague: Mouton.

Klein, D., Mok, K., Chen, J. K., & Watkins, K. E. (2014). Age of language learning shapes brain structure: a cortical thickness study of bilingual and monolingual individuals. *Brain and Language, 131*, 20-24. http://dx.doi.org/10.1016/j.bandl.2013.05.014

Kozulin, A. (2005, April). *Who needs metacognition more: Teachers or students*. Paper presented at the annual meeting of American Educational Research Association, Montreal, Canada.

Lamb, S. M. (1999). *Pathways of the brain: The neurocognitive basis of language*. Amsterdam: John Benjamins Publishing.

Ledesma, J. G. M. (1979). *Psicología del aprendizaje* [Psychology of learning]. Mexico: Progreso.

Li, P., Legault, J., & Litcofsky, K. A. (2014). Neuroplasticity as a function of second language learning: anatomical changes in the human brain. *Cortex*, *58*, 301-324. http://dx.doi.org/10.1016/j.cortex.2014.05.001

Lockhart, R. S. (2002). Levels of processing, transfer-appropriate processing, and the concept of robust encoding. *Memory*, *10*(5/6), 297–403.

Longman Concise English Dictionary (1985). Harlow: Longman Group Ltd.

Mandler, G. (2001). Remembering. In G. Underwood (Ed.), *Oxford guide to the mind* (pp. 30–32). Oxford, UK: Oxford University Press.

Mandler, G. (2002). Organisation: What levels of processing are levels of. *Memory*, *10*, 333–338.

Mårtensson, J., Eriksson, J., Bodammer, N. C., Lindgren, M., Johansson, M., Nyberg, L., & Lövdén, M. (2012). Growth of language-related brain areas after foreign language learning. *NeuroImage*, *63*(1), 240-244. http://dx.doi.org/10.1016/j.neuroimage.2012.06.043

Mayer, J. D., Salovey, P., & Caruso, D. R. (2000). Emotional intelligence as zeitgeist, as personality, and as a mental ability.

McVee, M., Dunsmore, K., & Gavelek, J. (2005). Schema theory revisited. *Review of Educational Research*, *75*, 531–566.

Mechelli, A., Crinion, J. T., Noppeney, U., O'Doherty, J., Ashburner, J., Frackowiak, R. S., & Price, C. J. (2004). Neurolinguistics: structural plasticity in the bilingual brain. *Nature*, *431*(7010), 757-757. http://dx.doi.org/10.1038/431757a

Neisser, U. (1967). *Cognitive psychology.* Nueva York: Meredith.

Neves, D. M., y Anderson, J. R. (1981). Knowledge compilation: Mechanisms for the automatization of cognitive skills.

In J. R. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 86–102). Mahwah, NJ: Erlbaum.

Organisation for Economic Co-operation and Development. (2002). Definition and selection of competences (DeSeCo): Theoretical and conceptual foundations. Resource document. Swiss Federal Statistical Office. Retrieved from http://www.bfs.admin.ch/bfs/portal/fr/index/infothek/erhebungen__quellen/blank/blank/deseco/02.html.

O'Malley, J. M., & Chamot, A. U. (1990). *Learning Strategies in Second Language.* Cambridge University Press.

Ortega Loubon, C., & Franco, J. C. (2010). Neurofisiología del aprendizaje y la memoria. Plasticidad Neuronal [Neurophysiology of learning and memory. Neuronal plasticity]. *Archivos de Medicina, 1*(6), 1–7. http://dx.doi.org/10:3823/048

Oxford, R. (1990). *Language learning strategies: what every teacher should know.* New York: Newbury House.

Oxford, R. (2013). *Teaching and researching language learning strategies*. Routledge.

Paivio, A. (1971). *Imagery and verbal processes.* Nueva York, NY: Holt, Rinehart & Winston.

Paivio, A. (1986). Dual coding and episodic memory: Subjective and objective sources of memory trace components. In F. Klix and H. Hafgendorf (Eds.), *Human memory and cognitive capabilities: Mechanisms and performances* (pp. 225–236). Amsterdam: North-Holland.

Robbins, S. E. (2009). The COST of explicit memory. *Phenomenology and the Cognitive Sciences*, *8*, 33–66.

Rose, H. (2012). Reconceptualizing Strategic Learning in the Face of Self-Regulation: Throwing Language Learning Strategies out with the Bathwater. *Applied Linguistics, 33*(1), 92–98. http://dx.doi.org/10.1093/applin/amr045

Rubin, J. (1975). What the good language learner can teach us. *TESOL Quarterly, 9* 41–51. http://dx.doi.org/10.2307/3586011

Rubin, J. (1981). Study of cognitive processes in second language learning. *Applied Linguistics*, *11*, 117–31. http://dx.doi.org/10.1093/applin/II.2.117

Rubin, J. (1989). *How learner strategies can inform language teaching in Proceedings of LULTAC*. Hong Kong: Institute of Language in Education.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, cognition and personality*, *9*(3), 185-211.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic information processing, II: Perceptual learning, automatic attending, and a general theory. *Psychological Review*, *84*, 127–190.

Stanovich, K. E. (2000), *Progress in understanding reading: Scientific foundations and new frontiers.* Nueva York, NY: Guilford Press.

Stein, M., Federspiel, A., Koenig, T., Wirth, M., Strik, W., Wiest, R., Brandeis, D., & Dierks, T. (2012). Structural plasticity in the language system related to increased second language proficiency. *Cortex*, *48*(4), 458-465. http://dx.doi.org/10.1016/j.cortex.2010.10.007

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.

Sternberg, R. J. (1990). *Metaphors of mind: Conceptions of the nature of intelligence*. New York: Cambridge University Press.

Sternberg, R. J., & Sternberg, K. (2009). *Cognitive Psychology*. California: Wadsworth.

Treisman, A. M. (1960). Contextual cues in selective listening. *Quarterly Journal of Experimental Psychology*, *12*(4), 242–248.

Tulving, E., & Osler, S. (1968). Effectiveness of retrieval cues in memory for words. *Journal of Experimental Psychology*, *77*, 593–601.

Tulving, E., & Thomson, D. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80* (5), 352–373.

Villanueva, E. B. (2008). Habilidades y competencias lingüísticas. In A. Escamilla, *Las competencias básicas. Claves y propuestas para su desarrollo en los centros* (pp. 189–203). Barcelona: Graó.

Villar, F. (2003). Psicología cognitiva y procesamiento de la información [Cognitive psychology and information processing]. Resource document. Universitat de Barcelona. Retrieved from http://www.ub.edu/dppsed/fvillar/principal/pdf/proyecto/cap_06_proc_info.pdf.