Cognitive Principles and CALL Grammar Instruction: A Mind-Centered, Input Approach

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ABSTRACT

Cognitive learning theories increasingly inform the creation and design of Computer Assisted Language Learning (CALL) materials. Recent discussions have explored the potential benefits of underscoring CALL materials with socio-cognitive learning theories such as situated cognition (Salaberry 1996; Renié & Chanier, 1995). However, Reynolds, Sinatra, and Jetton (1996) remind educators that there are principally two types of learning theories, both of which enjoy empirical verification: experience-centered theories, like situated cognition, and mind-centered ones, such as those theories that recognize the importance of providing learners with comprehensible input (e.g., Krashen, 1982). Even if Krashen's theory of comprehensible input is empirically untenable, it is important to keep in mind that no documented cases of successful foreign language acquisition exist without exposure to some sort of comprehensible input (Long, 1990). Thus, CALL materials designers and educators should continue to explore mind-centered theories. Drawing on the latest advances in our understanding of the interaction between internal cognitive processes and foreign language learning—specifically, VanPatten's (1993) Processing Instruction framework—this author outlines principles with which CALL educators can design effective input-oriented tasks targeting grammar instruction. The article concludes with the presentation of a prototype CALL application implementing these principles.

KEYWORDS

Cognitive Science, Computer Assisted Language Learning, Foreign Language Acquisition, Grammar, Input, Intake, Learning Theory, Situated Cognition.

INTRODUCTION

Cognitive learning theories, which account for learning based on hypotheses about learners' socio-cognitive and internal processes, inform the study of Second Language Acquisition with increasing frequency. For example, foreign language educators today guide their students to read authentic texts in the target language by helping them to tap into their schemata (i.e., background knowledge) relating to the content of such texts (Swaffar, Arens, & Byrnes, 1991). Foreign Language educators are also beginning to depend on cognitive learning theories to provide them with viable principles for the creation of Computer Assisted Language Learning (CALL) tasks. Perhaps because the public and educators today expect technology to bridge long distance communication gaps (Collins & Berge, 1995), some CALL educators have recently submitted that applications and tasks ought primarily to be premised on socio-cognitively oriented theories such as situated cognition (e.g., Salaberry, 1996). Nonetheless, valid cognitive theories are available to educators which underscore the importance of considering the internal processes responsible for learning. Krashen's (1982) Input Hypothesis and VanPatten's (1993) Processing Instruction framework rely heavily on research into these internal processes. Collentine (1997a) proposes that CALL applications could be particularly effective at fomenting the development of grammatical competence because such applications are rich sources of comprehensible input. This article expands on that proposition, providing foreign language educators with an internally-oriented cognition based framework within which to create CALL materials for grammar instruction. Furthermore, the author provides an example of how these cognitive principles could operate in a CALL environment by describing a software prototype that targets the instruction of the Spanish subjunctive within a modified version of VanPatten's Processing Instruction framework.

BACKGROUND

General learning theories have informed foreign language instruction and materials designers for over three decades (Ellis, 1990). The best known example is the arguably revolutionary changes (both curricular and technological) that occurred in foreign language curricula when methodologists designed syllabi and instructional materials following behaviorist assumptions, which ultimately led to Audiolingualism (Schwartz, 1995). As of late, cognitive learning theories have helped foreign language educators to consider how learners' internal processing mechanisms manage and store information about the target language (Hulstijn & Schmidt, 1994). To be sure, Krashen's (1982) Natural Approach essentially repre-

sents a Second Language Acquisition manifestation of the broader cognitive research agenda in an attempt to understand why certain skills are more readily learned explicitly (i.e., with attentional awareness) and others implicitly (Bialystock, 1994; Tomlin & Villa, 1994). Furthermore, VanPatten's Processing Instruction framework essentially brings to foreign language instruction recent discoveries in the study of how attention and short term memory interact with input to create representations of the foreign language in long term memory.[1]

Cognitive learning theories are just beginning to inform the design of CALL materials. Salaberry (1996) as well as Renié and Chanier (1995) have advocated the benefits of "situated cognition." Methodologists interested in situated cognition contend that the acquisition of new knowledge structures results from social interaction with similar and more capable peers (see Vygotsky, 1978). To give a concrete example, Zhoa (1996) outlines the potential benefits of Web based tasks that involve learners in so called "virtual communities," where students use the foreign language in the same contexts in which proficient speakers would use the language. In these virtual communities, students publish their writings on the Web after having completed the process of negotiating meaning with collaborators and co-constructing texts with fellow learners and native speakers. Presumably, the socio-cognitive interchanges that lead to the final published product facilitate the internalization of new knowledge about the target language and inspire learners to seek additional learning opportunities.[2] While Zhoa's work is an example of how pedagogues can draw on notions of situated cognition, researchers such as Salaberry (1996, p. 25) submit that such notions ought to form the principal premises underlying most Computer Mediated Communication (CMC) tasks.

> I believe that the implementation of pedagogical tasks in CMC environments should be attentive to two important features of the design process: the nature of interaction among humans (communication paradigm) and the roles of the learner in such interaction (language learning goals).

Nevertheless, it is essential to keep in mind that learning theories premised on the benefits of situated cognition represent only one of a variety of cognitive learning theories accounting for how human learning occurs. Reynolds, Sinatra, and Jetton (1996) remind educators that there are principally two types of learning theories, both of which enjoy empirical verification: experience-centered theories and mind-centered theories. Experience-centered models, such as the theory of situated cognition, emphasize that learning is functionally motivated. Learning entails the evolution and adaptation of knowledge so that learners' behaviors can emulate the behaviors of those who have been successful in the external environment

in which one uses that knowledge. Mind-centered models emphasize that learning can also be explained in terms of the "data" one receives about a particular phenomenon and how those data become internalized. These models describe how long term memory structures (e.g., knowledge) change in response to the manner in which one's attentional resources and short term memory process stimuli (i.e., information about the characteristics of what is to be learned). Thus, while situated cognition is a valid consideration for the creation of CALL applications, theories about mind-centered learning should also inform such applications.[3]

Have researchers made recent attempts to make CALL applications compatible with principles of mind-centered learning? Intentional or not, many applications today presuppose that tapping into learners' schemata (i.e., background knowledge) for a particular phenomenon enhances learning, such as those that depend on multimedia solutions for the delivery of content (see Davey, Jones, & Fox, 1995). Other researchers have considered mind-centered theories in their attempts to maximize the potential of CALL environments, especially those interested in the metacognitive processes that become a part of foreign language learners' strategic competence (Liou, 1997; Oxford, 1990). Collins and Berge (1995) as well as Warschauer, Turbee, and Roberts (1996) have argued that CALL applications increasingly allow students to assume autonomous control of their learning. However, it is important to note that the study of learning strategies does not necessarily lead to either an experience-centered or a mind-centered theory of learning; instead, educators interested in both types of theories draw on the study of learners' strategies to confirm and refute hypotheses.

Salaberry (1996) notes that Krashen's Input Hypothesis, a mind-centered theory, has underscored several CALL applications in the last decade. The Input Hypothesis predicts that acquisition results from exposure to meaningful written and aural input. Unfortunately, since many of the core tenets of the Input Hypothesis are currently viewed as suspect, the efficacy of relevant applications also becomes questionable. As Salaberry states (p. 9),

> [Krashen's] theoretical approach does not invalidate the pedagogical value of those CALL programs. However, it does raise some concerns about the validity of embracing such a monolithic approach in a field of inquiry with so many theoretical perspectives. More specifically, the history of support of Krashen's perspective is not comforting considering the fact that many researchers have argued forcefully against Krashen's hypotheses.

Salaberry's essential response to such shortcomings is to propose that CALL applications should primarily draw on experience-centered theo-

ries of learning, such as situated cognition. However, in light of Reynolds et al.'s (1996) assertion that empirically justifiable experience-centered as well as mind-centered learning theories do exist, it is premature to argue that CALL applications should primarily be informed by the principles of situated cognition. Indeed, Collentine (1997a) argues that peer collaboration in many CMC environments (e.g., on-line learning environments) must still deal with a variety of obstacles. He proposes that the technological solutions available to today's foreign language educators best lend themselves to input oriented tasks. Additionally, rejection of learning theories emphasizing the parameters of a mind-centered learning experience would ignore an observation that Long (1990) offers, despite the criticisms of the Input Hypothesis. Long declares, essentially, that while the sum of Krashen's hypotheses may be untenable, there are nevertheless no reported cases of successful foreign language acquisition without exposure to meaningful input and that there is a logical reason for reasserting the importance of input in foreign language education. Although tasks that encourage collaboration and production of some sort can consolidate and lead to the restructuring of already established knowledge structures (Nobuyoshi & Ellis, 1993), reading and listening to the target language is a necessary first step since it provides the data for the accumulation and building of new knowledge structures (VanPatten, 1993). Once such new knowledge structures have been established, tasks that involve situated learning can then modify and reorganize those new structures.

A MODIFIED VIEW OF INPUT AND ITS IMPLICATION FOR CALL APPLICATIONS

How might CALL developers provide foreign language educators with materials that simultaneously acknowledge mind-centered learning theories and recognize that foreign language acquisition necessitates some form of input-oriented instruction? An answer to this question partially lies in an understanding of the principal shortcomings of the Input Hypothesis. Apart from the empirical problems of Krashen's model (i.e., the claim that learners have two types of knowledge stores—acquired and learned—is not falsifiable), providing learners with comprehensible input appears to be ineffective at promoting the acquisition of grammar, at least from the perspective of the teacher (Terrell, 1991). The question arises as to why many learners do not acquire grammar incidentally from input. Many grammatical items are regularly accompanied by lexical redundancies, and the message carried by these items is readily retrievable through contextual indicators. For example, learners will focus their attention on the adverb *Yesterday* rather than the inflection *-ed* to determine the time frame of the sentence *Mary called John yesterday*. In a sentence such as *Antonio*

lo compró 'Antonio bought it,' students need only to understand the events of the surrounding speech situation (e.g., Antonio was looking for a new car) to determine that what Antonio bought was masculine, singular; they do not normally need to processes the pronoun *lo*. Thus, the input that students receive must somehow direct them to focus their attention on grammatical structure.

VanPatten (1993, 1995) addresses this pedagogical dilemma by proposing a revised input-oriented methodology of grammar instruction, termed "Processing Instruction." Processing Instruction has two core assumptions: (1) the acquisition of grammar can occur within an input-rich learning environment and (2) the acquisition of grammar can only occur when relevant tasks focus learners' attention on the semantic contribution of the grammatical item in question to its surrounding sentence. Briefly, this approach provides students with "structured input" tasks which elevate the "communicative value" of specific grammatical structures. The elevated communicative value of the grammatical structure increases the likelihood of grammatical acquisition by facilitating the intake of that structure from the input. It is important to emphasize here that linguistic stimuli are processed by the learner's attentional system along a continuum of sorts; some stimuli receive focused attention and others only peripheral attention. Intake is that subset of the input on which the learner's attentional resources focus (Tomlin & Villa, 1994). In a task in which students are to concentrate on the overall message conveyed by the input, raising the communicative value of a grammatical structure guides their attentional resources to detect (i.e., notice) the formal and semantic features of the grammatical stimulus. Under these conditions, the grammatical stimulus has a high probability of altering the learner's underlying grammatical competence (i.e., acquisition is likely). Cognitive processes that are psycholinguistic in nature (e.g., those stemming from principles and parameters of Universal Grammar) use intake to create an internal representation of the target structure (VanPatten, 1995).

A structured input task would prompt a student to determine whether *Mary called John yesterday* occurred in the past by omitting the redundant lexical marker of time, "*yesterday*". As an input-oriented approach to grammar instruction, Processing Instruction has proven to be remarkably effective.[4] Several studies have not only shown that this mind-centered methodology can facilitate the acquisition of phenomena such as the Spanish preterit but also abstract phenomena such as the assignment of the accusative case to direct-object pronouns and the Spanish subjunctive in adjectival clauses (Cadierno, 1995; VanPatten & Cadierno, 1993; Collentine, in press).

Unfortunately, even Processing Instruction as it is currently conceived has limited potential as a means of providing a mind-centered, input-oriented approach to grammar instruction. As noted above, regardless of the

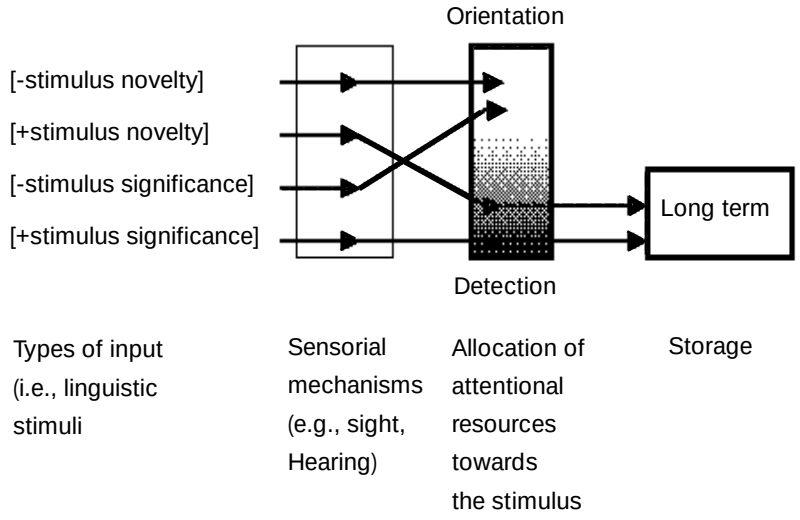
specific nature of the task, the principal strategy for elevating a grammatical structure's communicative value is the omission of the structure's lexical redundancies. However, many important uses of grammar require lexical redundancy (Givón, 1984). Collentine (1997b) argues that structured input tasks cannot elevate the communicative value of structures such as the Spanish subjunctive in nominal clauses.

(1) Quiero que María cante.	'I want Mary to sing.'
(2) Dudo que María cante.	'I doubt that Mary sings.'
(3) Es maravilloso que María cante.	'It's great that Mary will sing.'

To help learners detect the subjunctive mood in sentences 1-3, a structured-input task would presumably prompt comprehension of the sentences without the redundant markers of modality found in their main clauses, yielding simply *Que María cante*. The only possible interpretation of this sentence, however, is one of coercion—'Let Mary sing'. Thus, structured-input tasks currently cannot help learners attend to the quite common uses of the subjunctive referred to as doubt, denial, and emotive uses. On the other hand, if a structured input task were to present students with sentences 1-3 with their lexical redundancies, learners would probably not even detect the presence of the subjunctive morpheme, thereby making its internalization in long-term memory unlikely (Leow, 1993). For brevity's sake, structures that either need or cannot occur without their lexical redundancies will be termed herein "redundancy-dependent structures."[5]

Collentine (1997b) proposes that, with a broader view of the interaction between linguistic stimuli (input) and detection (the cognitive processes that lead to intake), tasks premised on the two core assumptions of Processing Instruction could effectively promote the acquisition of even redundancy-dependent structures. It is further proposed here that the unique features of CALL tasks make digital solutions particularly suited to providing students with structured-input tasks targeting these structures. (See Figure 1.)

Figure 1
Processes Involved in the Long Term Storage of Input



Note. Based on Cowan (1995), Tomlin and Villa (1994), and VanPatten (1993).

According to Cowan (1995), detection of a grammatical stimulus by the learner's attentional resources depends on whether the stimulus has one of two properties. First, the attentional resources will detect the target structure if it has stimulus significance, that is, if the completion of the task requires that the learner engage the structure. For example, if a learner is to determine the time frame of *John called Mary* without lexical redundancies, previous research has suggested that learners will eventually engage the *-ed* inflection and attend to its meaning. Second, attentional resources will detect the target structure if the structure has stimulus novelty. If a stimulus is somehow 'physically salient' (is presented in a different font, exhibits some kind of linguistic irregularity, or has unique acoustic features), it is likely to be perceived as novel by the attentional system. Consequently, the attentional system will devote a majority of its resources to that novel stimulus. For example, Leow (1993) presents evidence suggesting that learners of Spanish are more likely to intake the present perfect (e.g., *he trabajado* 'I have worked') than they are to intake the present subjunctive (e.g., *trabaje* 'I should work') because the present perfect does not represent a morphophonemically prototypical verb paradigms since it

spans two words rather than one. Cowan would attribute learners taking in more present perfect items than subjunctive items to the fact that the present perfect presents a novel verb stimulus (see Collentine 1997b). Therefore, a CALL based input-oriented task must somehow do two things: (1) increase the likelihood that structures such as the subjunctive present novel stimuli to learners and (2) ensure that learners can readily associate a meaning (i.e., semantic features) with those novel stimuli.

THE EFFICACY OF COMPUTER BASED LEARNING ENVIRONMENTS AS PROVIDERS OF DATA

It is worthwhile to explore whether empirical motivation can be found for using computer based environments as a way to enhance mind-centered learning. According to Lehrer (1993, p. 200), in an environment in which it is important for learners to engage data about a particular phenomenon, one of the principle advantages of computer based tools over text based tools is that computers have the ability to provide "multiple layers" of data simultaneously. Multiple layers allow students to explore a single phenomenon (or even a single example) while taking note of important features of the phenomenon put into relief by the use of text, graphics, animations, sound, and video.

Such observations should not be understood to imply that CALL applications ought to flood learners with data. In his review of the available research on the effectiveness of hypermedia learning environments from a mind-centered perspective, Tergan (1997) points out that a major drawback of applications providing students with myriad stimuli and data is that they are minimally beneficial to novice learners or to learners who come to the learning task with few knowledge structures with which to engage the new data. The most effective applications take the principle of "selective fidelity" into account (Andrews, Carroll, & Bell, 1995). Multiple-layered tasks should provide only those channels of stimuli that are necessary to enable learners to form hypotheses about a new knowledge structure and to modify existing knowledge structures. In a CALL environment, the principal stimulus candidates appear to be text, sound, and video. Mann (1995) reports that hypermedia learning environments can be particularly effective when they present information with text accompanied by sound (i.e., as opposed to either text or sound alone). Taken altogether, the research above suggests that multiple layers of data about a new phenomenon can yield an effective learning environment if the application designer limits the number of layers to a select, relevant few.

The essential question on the efficacy of computer based learning environments focuses, then, on whether CALL applications can facilitate the detection of redundancy-dependent structures. Collentine (1997b) pre-

sents evidence suggesting that, in input-oriented tasks requiring students to focus on the message conveyed by the language input, learners will indeed engage such structures provided that items representing the targeted structure possess stimulus novelty. He shows that computer environments can direct learners to process input from a bottom-up perspective, even when the ultimate goal requires top-down processing (i.e., attending to meaning). In such environments, students do in fact detect structures such as the Spanish subjunctive in nominal clauses when the input contains so called irregular subjunctive forms (e.g., *seamos* 'we should be,' *tengamos* 'we should have').

CALL TASKS AND ELEVATING THE STIMULUS NOVELTY OF GRAMMATICAL ITEMS

This section outlines the general principles for the creation of structured-input tasks that facilitate the intake of grammatical structures with limited potential for communicative value (i.e., those structures whose lexical redundancies cannot be eliminated).

As Figure 1 implies, the primary goal of a structured-input task purporting to raise the communicative value of a redundancy-dependent structure is to increase the stimulus novelty of the structure's exemplars. According to Cowan (1995), the principal strategy for accomplishing such a goal is to make the stimulus physically distinct from its surrounding context. To this end, a CALL application can utilize both linguistic and nonlinguistic channels of information to draw students' attention to the target structure.

Oral delivery effectively enhances stimuli in linguistic channels. Leow (1995) reports that foreign language learners are much more likely to notice redundancy-dependent structures, when these structures are presented as aural input. He claims that aural input is much more likely to prompt learners to engage in bottom-up, data-driven processing strategies than textual input. For example, learners tend to notice unexpected sounds (novel inflections) at the end of familiar verbs, such as the use of the inflection *-a* with the verb *comer* (a present subjunctive inflection of the verb) in a sentence like *Quiero que lo comas* 'I want you to eat it.' These results in conjunction with those of Mann (1995) above suggest that a structured-input task in a CALL learning environment might well provide input containing meaningful uses of a redundancy-dependent structure with textual and aural support presented simultaneously. Another layer of (para)linguistic information could be kinesic information about the target structure (e.g., body language that accompanies coercion as well as affirmations of doubt and emotion). Such information could be displayed in pictures, animations, or digital video (Garza, 1996).

In the area of non-linguistic channels, research in the use of the variables which make instructional video an effective instructional device provides interesting insights. Investigations into so-called colorization have revealed that highlighting a target structure is not only useful to enhance listening and reading skills but productive skills as well (Bell, 1984; Garza, 1984, 1996). A structured-input task targeting a redundancy-dependent structure might make an item more perceptually salient to learners by presenting the item and its exemplar in a color different from the color of its surrounding context. For example, in the sentence *Quiero que lo comas ahora*, one could use the color red for *Quiero que lo* and *ahora* and blue for the word *comas*.

Up to this point, strategies for increasing the stimulus novelty of redundancy-dependent structures have been outlined. However, once a CALL application has increased the probability that learners will detect such a structure, it is also essential that they engage the structure's meaning. As argued earlier, it is not always possible to create tasks in which learners must engage the meaning conveyed by the redundancy-dependent structure alone. A structured-input task in a CALL learning environment must take an associative approach by (1) increasing the likelihood that learners will detect a redundancy-dependent structure and (2) ensuring that learners somehow contemplate the meaning of the sentence encapsulating the target structure. A technique that has proven effective in prompting the intake of structures that are not redundancy-dependent (e.g., the Spanish preterit) has been to present learners with two situations, typically in the form of illustrations or cartoons (VanPatten, 1993). After studying each situation, students are shown a sentence containing the target structure and prompted to determine the situation that the sentence describes. For instance, students might view two cartoons of a young lady playing baseball; under one cartoon is the caption *La semana pasada* 'last week' and under the other *Ahora mismo* 'right now.' They could then be shown the sentence *Juana jugó al béisbol* 'Juana played baseball' and prompted to indicate that the sentence refers to the *La semana pasada* cartoon. Given the plethora of media with which multimedia CALL applications can contextualize the target language samples, these applications could present structured-input tasks that make the process of helping students to associate meaning with a redundancy-dependent structure highly meaningful.

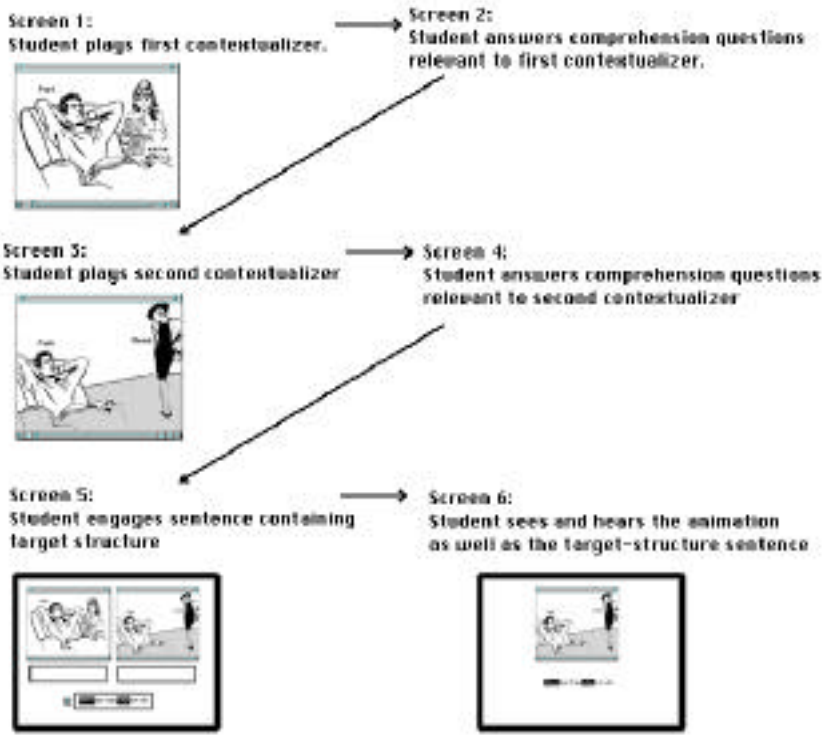
ILLUSTRATIVE PROTOTYPE APPLICATION

In an attempt to implement the principles described here, this writer designed a prototype application entitled "Subjunctive Discoveries." The application, authored with Macromedia's Director Studio, is a multimedia environment in which students have multiple opportunities to intake

the Spanish indicative/subjunctive distinction in nominal clauses. The application, meant to supplement instruction in the subjunctive, contains no explicit explanation of the subjunctive.

The "Subjunctive Discoveries" program consists of a series of fifty "contexts," each of which presents learners with two semi-animated situations. The program instructs students to report on what they see by answering questions. Ultimately, each context allows learners to contemplate the meaning conveyed by a sentence containing a nominal clause (*Quiero* [cp/np *que lo comas*]) as well as to take note of the mood of the subordinate clause (indicative or subjunctive) and the meaning of the main clause of the sentence (e.g., coercion, doubt, or evaluation). (See Figure 2.)

Figure 2
Program Sequence for the Contexts of Subjunctive Discoveries



Each context consists of two contextualizers, or semi-animated digital

videos. One of the purposes of the contextualizers is to set the pragmatic stage for the sentence (its meaning or function) that contains the target structure. The dialogues that students hear in screen 1 and screen 3 are

Dialogue involving *Papá* and *Anita*	Dialogue involving *Papá* and *Mamá*
Anita: Papi, ¿puedo salir a jugar con mis amiguitos? *Papá: Ahora no. Vamos a comer pronto.*	*Mamá: Esta noche salimos a comer. ¿Te acuerdas?* *Papá: O...Sí. ¡Claro!*
(Anita: Daddy. Can I go outside to play with my friends? Father: Not now. We're going to eat soon.)	(Mother: Tonight we're going out to eat. Remember? Father: Oh, yeah. Sure!)

To ensure that learners concentrate on the pragmatic circumstances surrounding the digital video, the program prompts them to watch each animation on a separate screen and then to answer corresponding comprehension questions involving multiple-choice, one-word, and true-false answers (Swaffar, Arens, & Byrnes, 1991). All video playback features remain enabled so that students can play the animation and listen to its dialogue as frequently as they wish.

After viewing the animations and answering relevant questions, students proceed to the next screen in the context, termed here the Target Structure Engagement Screen (TSES). The TSES presents students with the two digital videos and prompts them with an engagement sentence, the input sentence containing the target structure. (See Figure 3.)

Figure 3
Sample Target Structure Engagement Screen

Listen to the sentence, then drag it to the animation that it best represents.

For ease of reading, the engagement sentence is presented in a large sans serif font. To raise the stimulus novelty of the target structure and to help learners associate the structure with its lexical redundancies, the TSES colorizes the target structure (the verb in the subordinate clause) and the verb of the main clause in blue. The TSES instructs learners to listen to the engagement sentence's corresponding sound file and then to drag the sentence into the box below the animation that the engagement sentence best describes. The drag-and-drop capability is not enabled until students listen to the engagement sentence's aural representation. Feedback is non-linguistic; the TSES allows students to drop the sentence only into the correct box. The author felt that linguistic feedback (e.g., a textual message indicating right or wrong) for the drag-and-drop protocol might interfere with students' processing of the engagement sentence in short term memory. After students successfully complete the drag-and-drop task, a final screen appears in which a colorized version of the engagement sentence is displayed below the correct animation while the animation plays. When the animation finishes, the sound file for the engagement sentence is played. After comparing the pragmatic information contained in the animations and in the engagement sentence *Desea que salga con ella* 'She wants him to go out with her,' students should be able to determine that

the engagement sentence best represents the animation involving *Papá* and *Mamá*.

FINAL REMARKS

This article has explored one way of incorporating cognitive learning principles into the design of CALL applications targeting grammar instruction. It is proposed here that designers should inform their applications not only with experience-centered learning theories, such as situated cognition, but also with mind-centered theories, such as those that posit that some form of comprehensible input is a necessary condition for grammatical development. Specifically, it is suggested that CALL applications can be particularly effective at facilitating the intake of grammatical structures that normally have little communicative value in input.

It is important to note that although ample empirical evidence supports the assumptions that underlie the design of the prototype application sketched here, its validity and reliability still require verification. It is hoped that CALL application designers will continue to explore ways of incorporating these assumptions into grammar oriented applications. More important, developers should consider a variety of learning theory principles in the design of their CALL applications which will ultimately lead to a sounder foreign language curriculum in general.

NOTES

[1] Ellis (1990) and VanPatten (1994) caution that cognitive learning theories and the research on the acquisition of phenomena such as artificial grammars cannot fully account for the acquisition of a second or foreign language. They contend that language is a unique human ability and that specific psycholinguistic principles and mechanisms, such as those in Universal Grammar, lead to language learning.

[2] CALL is not only discipline in which the benefits of situated cognition are being explored. Nicaise (1997) reports that advances in the understanding of how situated cognition assists skills development have led to improvements in the efficacy of computer assisted learning materials in mathematics and science.

[3] A consideration of both experience- and mind-centered theories would seem especially appropriate given that students possess a myriad of learning styles (see Oxford, 1990).

[4] Studies such as the one by Salaberry (1997) have shown that Processing Instruction is not necessarily more effective than traditional (i.e., output-oriented) approaches to grammar instruction. Yet, as Collentine (in press) and Ellis (1998)

note, such research does indicate that Processing Instruction is a viable alternative to traditional approaches.

[5] Another example of a redundancy-dependent structure is the number inflection that must be encoded into the past participle of passive constructions. In sentences such as *La pelota fue pegada por Juan* 'The ball was hit by John' and *Las casas fueron pintadas por María* 'The houses were painted by Mary,' it is difficult to make number inflection salient for learners because it will always be redundantly marked either in the subject or the copula *ser*.

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