What Cognitive Processes Are Triggered by Input Enhancement?

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ABSTRACT

Recently in Second Language Acquisition research much attention has been focused upon the cognitive mechanisms that underpin learner processing of input. In studies of how second language instruction has an effect on L2 learner's subsequent processing of input, researchers have examined how external manipulation of input can affect intake and subsequent learning. In this literature review, input enhancement (an instantiation of manipulated input) will be examined in light of current cognitive psychological models of attention and memory. After reviewing current models of attention and memory as they pertain to SLA, previous input enhancement studies will be analyzed in order to see how input enhancement could affect L2 learner processing. Particular attention will be paid to the potential triggering effects of input enhancement as well as its impact upon second language learning.

INTRODUCTION

Traditionally, a distinction has been drawn between linguistic *input* that the learner has yet to process and *intake,* the mental registration of the input that occurs after processing (Corder, 1967). Recent Second Language Acquisition (SLA) research has highlighted the ways in which *attention* mediates the process of selection and subsequent memory of input. Examining the role L2 instructional tasks play in this process of input selection has elicited a variety of responses: *consciousness raising* (Sharwood Smith, 1981), *focus on form* (Long, 1991), and *analytic teaching* (Lyster, 1994) to name a few. Also, in the history of SLA research, consciousness has played a pivotal role. Krashen (1982) has argued that a distinction exists between largely *unconscious* acquisition and predominately *conscious* learning. In his conceptualization of consciousness, adult second language learners have access back to the innate mechanisms that guide L1 acquisition, and conscious learning has a minimal impact on the ability to use an L2. However, one group of SLA researchers (Schmidt, 1990, 1995, 2001; Schmidt & Frota, 1986) has claimed that conscious attention to input is necessary for learning to take place. By consciously noticing specific forms in the input, Schmidt claims, we subsequently learn an L2. Another group of SLA researchers (Tomlin & Villa, 1994) claims that detection, attention without conscious awareness or noticing, is a key process in SLA. Tomlin and Villa assert that

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detected information can be registered in memory and disassociated from awareness. Other researchers such as Truscott (1998) view the process of second language learning as dualistic in nature: the acquisition of metalinguistic forms may be tied to conscious noticing, but competence in the second language is not. Recently in the SLA literature, cognitive psychological and psycholinguistically motivated conceptual distinctions between consciousness and unconsciousness have emerged (Doughty, 2001; Robinson, 2003). As a result, we have gained a clearer understanding of both the conscious and unconscious cognitive mechanisms underlying learner language development. This debate in the field concerning the role of consciousness has also had a marked influence on a concurrent discussion of the role instruction plays in SLA. In particular, researchers have attempted to measure how external manipulations of input vis-à-vis instruction may affect learning.

In theorizing about the possible effects of instructed input upon potential learning, Sharwood Smith (1991) begins by looking at the cognitive processes in second language development with special reference to input the learner is exposed to, which contains evidence about the target language system, and the role of consciousness. In particular, Sharwood Smith wanted to investigate the various interfaces between different cognitive systems in the adult mind. His research considers three crucial areas that are highly relevant to second language acquisition research, namely the respective roles of conscious (meta) linguistic analysis and cognitive processes involved in the computation and storage of language which are inaccessible to consciousness, as well as the interface between A and B in the L2 learner's processing of input. Taking this model of cognitive processing into account, Sharwood Smith (1993) derives the rationale for input enhancement by examining how L2 proficiency develops as a response to the types of input the learner receives. Central to his discussion is the role instruction plays in the process of facilitating L2 learner's selection of input for processing. In particular, Sharwood Smith (1993) explores the possible effects of focusing learner attention to specific aspects of the input, which in turn could lead to further cognitive processing. Initially three options for the L2 learner are given in this conceptual framework: (a) input that is fleetingly registered in the L2 learner's short term memory and then discarded, (b) selected input that is processed and yields an interpretation, and (c) selected input that triggers a restructuring of the learner's current language system. In describing options two and three, Sharwood Smith (1993) refers to *input salience* as affecting this internal process of selection and possible subsequent error detection. The greater saliency a particular form has in the input to which the learner is exposed, the greater the chances are for it to be selected by the L2 learner. Input enhancement is one way in which input saliency is increased.

Sharwood Smith (1993) proposes two types of input enhancement: positive and negative input enhancement. Positive input enhancement highlights the salience of correct forms in the input. An example of this would be visual input enhancement of a reading text in which targeted form are bolded, underlined, capitalized or italicized. Negative input enhancement would highlight errant forms. An example of this would be error flags which would draw learner attention to their mistakes In addition, two types of salience of input are introduced: internally derived salience (or input that becomes noticeable to the learner because of internal cognitive changes and processes) and externally derived salience (input becomes more noticeable because the manner of exposure is changed).

In this paper, the underlying cognitive processes that could be triggered by input enhancement will be explored in light of recent research into cognition and SLA. The idea is to see what effects input enhancement has had (or has failed to have) on the L2 learner's processing of input. Crucial to this discussion is a speculative glimpse at the environments where input enhancement may or may not trigger certain cognitive processes such as attention and memory. After a review of the relevant psycholinguistic processes (i.e., memory and attention) as well as previous input enhancement studies, the potential impact of input enhancement upon attention, memory and potential learning will be appraised.

ATTENTION, MEMORY & SLA

In the field of Second Language Acquisition, researchers such as Schmidt (1990, 1995, 2001), Tomlin and Villa (1994), Robinson (1995, 2003), and Doughty (2001) have taken several concepts from the fields of Psycholinguistics and Cognitive Psychology in formulating their ideas. For the purposes of this paper, I would like to examine the cognitive processes of Attention and Memory as they pertain to SLA in general. Attention has been subdivided by Robinson (1995, 2003) into three subprocesses: Attention as Selection, Attention as Capacity, and Attention as Effort. Even though all three processes are important in SLA, I would like to examine the first two processes, as they are most pertinent to the subsequent discussion of input enhancement.

Differing Accounts of Attention & Selection

Schmidt's noticing hypothesis

The concept of attention has been central to most theoretical accounts of how the process of second language learning takes place. A key figure in the discussion of attention in SLA has been Schmidt. Initially, while engaged in the process of analyzing the introspective data of his own second language learning experience, Schmidt and Frota (1986) proposed the notion of *noticing the gap*. In this case, the learner becomes consciously aware of how his/her interlanguage form differs from the target form. Later, Schmidt (1990) reasoned that learners must pay attention to input and have momentary episodes of noticing (an occurrence of momentary focal attention directed toward the input) in order for learning to take place. In this case learning must be conscious, Schmidt (1990) argues, because we must pay attention to the input in order to have the momentary subjective experience of noticing it. Schmidt (1990) also asserts that a higher level of awareness, rule understanding, while facilitative for learning is not strictly necessary. Schmidt (1995) subsequently further refines his definition of noticing as being "nearly isomorphic with attention," (p. 1). Thus, for Schmidt (1995), conscious attention to linguistic form is essential for successful second language learning.

Tomlin and Villa

Tomlin and Villa (1994) propose that attention is divided into three separate but related components: alertness, orientation, and detection, none of which require awareness. Alertness is the initial stage of attention and refers to the general readiness of a learner to receive input or stimuli. Orientation represents the learner's directing of his/her attention to certain incoming stimuli while ignoring other input. Detection, which Tomlin and Villa consider the most significant component of attention for second language acquisition, serves as the cognitive registration of sensory stimuli. Unlike Schmidt's conceptual framework, Tomlin and Villa do not see conscious noticing as necessary for detection to take place. Tomlin and Villa based a large part of their model on Posner and his research team's characterization of attention.

Posner's model from Cognitive Neuroscience

Posner and his colleagues (Posner & Dehaene, 2000; Rothbart & Posner, 2001) have proposed that three separate yet interactive networks of attention are operative in processing incoming stimuli: the orienting network, the alerting network, and the executive control network. First, the orienting network, located in the frontal lobe, is a largely involuntary processing area, which provides covert (largely unconscious) orienting to sensory, in particular, visual stimuli. For example, if a red flashing light began suddenly blinking on and off in my peripheral vision, I would most likely give it a sudden look. Thus, my eyes would be involuntarily drawn to the light. Second, the alertness network (located in the right frontal lobe), which is partially voluntary and involuntary, is involved in maintaining the alert state. This network manages to keep us alert and ready to react to incoming stimuli. The executive control network (located in the midline frontal area) has been related to goal directed behaviors such as target detection, error detection, conflict resolution, and inhibition of automatic responses. While the first two attentional networks develop during infancy, the executive control network has been shown to continue its development throughout childhood and well into adolescence. While all three networks are operative during the performance of a given task, the executive control network seems most susceptible to individual's conscious control.

In addition, Posner and Dehaene (2000) analysis of their neuroscientific data suggests that both genetics and the environment are two mediating factors upon an individual's attentional capacity and development of attention as a property of the brain. This information not only helps shed new light on individual variation in learner attention, but also gives us clues as to how environmental changes impact the process. Manipulation of the environment may bring about changes to an individual's attention, but the effects are not uniform.

Attention and Capacity

Task complexity plays an important role in determining how much of the L2 learner's attentional resources are expended at any given moment. Controlled processes are generally viewed as being less demanding than automatic processes (see De Keyser, 2001) in their effects on capacity of attention. Likewise complex tasks in the L2 are seen to create attention demands that can affect the accuracy, fluency or complexity of learner speech (Robinson, 2001a). Because learners have a finite pool of attentional resources, capacity limits can be exceeded during specific complex tasks. In particular, tasks which require reasoning and reference to many elements are more attention demanding than tasks which require a single activity and draw upon prior knowledge (Robinson, 2001b). Skehan (1998) argues that as learners' attentional capacity limits are reached, learners may begin to prioritize processing for meaning over processing for form. As a result, Skehan predicts that learners may begin to employ a strategy of paying attention to content words at the expense of grammatical morphology, which adversely affects student performance.

Memory

Cognitive psychological researchers have identified five basic memory stages: acquisition, registration, storage, access, and transfer (Baddeley, 1976, 1997).

Acquisition

The process of acquisition consists of exposure to the stimulus and selective intake (Baddeley, 1976, 1997). Acquisition relates closely to selective attention but it is also highly dependent upon exposure and experience. Clearly, it is much more difficult to acquire information to which we have had no prior exposure or any related experience. Baddeley argues that a continuum of consciousness mediates our selection of input and that it ranges from being a largely unconscious process to a highly conscious one. Once we have selectively attended to informative stimuli, our subsequent storage decision can range from a quick perusal with immediate forgetting or a highly conscious attempt to remember the stimuli.

Registration

Once we have attended to informative stimuli, our storage decision can range from a largely voluntary one to an involuntary one. Once the stimuli have been accepted into the processing system, data undergoes coding during which it is packaged into a usable format or system of representation (Melton, 1973). The individual can either choose to code a particular group of items phonetically or semantically. If an individual chooses to go the first route, the sounds of the items are retained with or without semantic associations attached. Learners encountering unknown lexical items or children encountering a word for the first time use this strategy (Baddeley, 1997). The second strategy, semantic coding matches the meaning of the word with the particular significance it conveys. Rehearsal, another essential component of this process (Atkinson & Shiffren, 1968), involves the covert or overt repetition of information to register it more firmly in memory. The most common form of this is the verbal rehearsal loop. For example, while memorizing a list of words a child might whisper them in order to reinforce the item's registration. Two levels of rehearsal have been identified: maintenance rehearsal and elaborative rehearsal (Chechile, Richman, Topinka, & Eherensbeck, 1981). In the former the memorizer simply repeats the data in some stereotyped way (for example, a child saying a word under her breath). In the latter, the memorizer elaborates on the information provided and adds associations or additional ideas. Robinson (1995, 2001a, 2001b, 2003) views these two processes (maintenance and elaborative rehearsal) as requiring focal attention. Both kinds of rehearsal engage the working memory, Robinson argues, and both involve the processes of detection awareness and noticing. This process will be described in more depth in a later section on the interface between attention and memory.

Storage

After registration of the stimuli, storage takes place in one of three areas: the working memory, the short-term memory, and the long-term memory. Working memory occurs as the shortest memory span during which an individual holds the data in mind while processing it. This enables a learner to return to an earlier part of a process or task and integrate it with other elements (Baddeley, 1976, 1997, 2000). Short-term memory has a remarkably short duration and limited capacity and is aided by the processes of coding. (Craik & Watkins, 1973). Short-term memory is characterized by a strong recency effect during which stimuli that has been registered last is remembered first. Lastly in the registration process is long-term memory. For information to be stored effectively within the long-term memory it first must be consolidated. Information that has been registered in some temporary form must be further encoded which could involve further analysis or relating the data to previous memory. In order to be effective, multiple associations with the new data lead to further consolidation in the long-term memory. There exist three other types of consolidations: seriation, categorization, and relational. Seriation is a process that organizes data in a particular sequence. Categorization is another process during which data are grouped according to a particular classification or category. The third organizing scheme entails the use of relational imagery. In this case an individual equates incoming data to highly meaningful visual images.

Access

Access involves finding information that has been stored in memory (Baddeley, 1976, 1997, 2000). Three basic overlapping patterns exist: association, recognition, and retrieval. Association involves forming discrete linkages between separate units of information. Associations formed during the encoding process into short-term memory can serve as a hook by which to retrieve it at a later point. Therefore, if one associated *peanut butter* and *jelly* together at the moment of encoding, it could be retrieved in the same manner with *peanut butter* triggering the memory of *jelly.* The second process recognition involves realizing that some particular information or set of stimuli has been encountered before. This process is highly dependent upon effective registration in short-term memory and then perhaps long-term memory. Depth of processing, coding, and rehearsal all affect recognitions ability to recognize information to which one has been previously exposed. The third process retrieval involves the recovery of entire sets of data. Cued recall is a subprocess that requires the giving of a substantial hint (such as in a crossword puzzle) in order for the speaker to derive the correct information. Free recall, on the other hand, does not require the retriever to excavate the data without any significant clues.

The interface between memory and attention

Robinson (1995, 2003) argues that the processing of information to the long-term memory from working memory involves encoding that is dependent upon additional processes known as *rehearsal*. He identifies two types of rehearsal: a data-driven process known as *maintenance rehearsal*, and a conceptually driven process known as *elaborative rehearsal*. Both types of rehearsal Robinson found can lead to learning but in somewhat different ways.

Maintenance rehearsal, which converts oral input into phonological form through a short-term memory process known as the *phonological loop* (Baddeley, 1997) leads to long-term memory encoding in an unanalyzed form. Following this model we can find that as representations of input accumulate in memory, automatized, inductive learning processes may help to break down these previously unanalyzed chunks of language. As Ellis (1996, 2001) found some (if not all) aspects of language learning can be viewed as a process of breaking down initially unanalyzed chunks of language in long-term memory into smaller more productive units. This automatized, data-driven process requires fewer cognitive resources than the elaborative-rehearsal process.

Robinson (1995) found that elaborative rehearsal, on the other hand, involves non-automatic learning processes, which are engaged by the learner's conscious intention to learn generalizations. This form of rehearsal he argues necessitates establishing connections between the information in short-term memory and the structures in long-term memory. New information, Baddeley (1997) argues, in effect, becomes embedded in old memory structures or what he terms the schemata. Thus, one could infer that the learner could consciously retrieve instances of previous input in attempt to derive a rule or a previously formed hypothesis and compare it to the current input. As Ellis (1996, 2001) argues learners are continuously engaged in this process of comparison in lexical acquisition. In order to derive word meanings, Ellis sees the learner clarifying current instances of a given lexical item by comparing it to previously hypothesized meanings. This instance of rehearsal can be seen as a conceptually-driven process that involves more cognitive demands than the other data-driven process.

As Williams (1999) points out data-driven and conceptually-driven modes of learning make somewhat different demands on the memory. Conceptually-driven learning he argues depends upon a much more selective sampling of incoming input data as well as a conscious choice of previously formulated hypotheses to be encoded in the long-term memory. Data-driven learning on the other hand is according to Williams less cognitively demanding as it merely requires large amounts of unanalyzed data to be encoded into the long- term memory in a largely unanalyzed form. Data-driven learning could therefore perhaps be seen as more amenable to implicit, less obtrusive pedagogical approaches than conceptually driven learning which may require more explicit instructional strategies (see Doughty, 2001, for a more detailed discussion of explicit and implicit pedagogical strategies and their cognitive correlates).

PREVIOUS STUDIES OF INPUT ENHANCEMENT

TABLE 1
Previous Input Enhancement Studies

Name of Study	Length of Treatment	Targeted Linguistic Form and Type of Treatment	Number of Participants	Pre-Treatment Assessment	Post Treatment Task(s)	Treatment Success
Alanen (1995)	2 sessions of 15 minutes	Locative suffixes in Finnish presented in enhanced text	36	None	6 written tasks and one think aloud protocol analysis	Yes
Doughty (1991)	10 Days	English relativization presented in highlighted text, reading for meaning tasks also administered.	14	written pre-test and oral production task administered to measure developmental readiness	4 written post-tests: 2 grammaticality judgment tasks and 2 sentence combination tasks 1 oral production task	Yes
Jourdenais et al. (1995)	one brief session	Spanish preterit/imperfect verbs presented in enhanced text	14	none	written story production task think aloud protocol	Yes
Leow (2001)	one brief session	Spanish preterit/irregular verbs presented in enhanced text	28	pre-test administered to detect lack of knowledge of targeted form	"on-line" think aloud protocol/written recognition and production task.	No
Robinson (1997)	One 25 minute session and one 2 minute session	English verb stems presented in enhanced text as well as in instructed group	60	none	Two written tasks	Limited
White (1998)	10 hours over a two week period and 2 to 3 hours a week over 5 month period	Reading text which include enhanced forms	60	pre-test administered to measure learner's developmental stage	two post tests: one delivered following the treatment, the second administered during the 19th week of the course	Limited: no long term memory effects noted
Williams (1999)		Italian pronoun use presented in enhanced text	16	none	two tasks: verbatim memory task and translation task	Yes

As stated previously, input enhancement has been devised as an implicit and unobtrusive means to draw the learners' attention to form contained in the input. The basic method of the enhancement is to simply increase the perceptual salience of the target form by utilizing combinations of various formatting techniques (e.g., bolding, capitalizing, or underlining) which in some studies may be accompanied by an explicit mention to the learners to attend to the highlighted form (see Table 1). When the particular form has been chosen as a target, it is embedded in the overall text. By using this means, the researcher aims to achieve the integration of attention to form and attention to meaning. (see Han, 2003 for a further explanation of how this integration of form and meaning works).

Previous studies of visual input enhancement have involved varying lengths of treatment and exposure to the input. Most of the studies have involved short-term treatments with somewhat limited exposure (in terms of both time and quantity) to the input (Alanen, 1995; Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995; Leow, 2001; Robinson, 1997; Williams, 1999). A few studies have involved longer-term treatments with a greater amount of input exposure (Doughty, 1991; White, 1998). The results of the treatments have been quite mixed. Three of these seven studies (Doughty, 1991; Joudenais et al., 1995; Williams, 1999) yielded positive findings for the facilitative effect of enhancement, whereas three studies elicited limited results (Alanen, 1995; Robinson, 1997; White, 1998) and one (Leow, 2001) found no positive effect at all. Although various design features make direct comparison of these studies difficult, some major factors are essential to understanding the benefits and limitations of current empirical research on visual input enhancement.

First, not all of the studies used input enhancement alone as a method of inducing the desired learning effects intended by the researcher. William's (1999) study, which showed the benefits of visual input enhancement, used a form-focused verbatim recall task in conjunction with visual enhancement. This task may have possibly induced greater noticing of the form than may have been possible alone. Similarly, Doughty (1991) found positive effects by of a meaning-oriented treatment that involved not only visual enhancement but other various forms of comprehension assistance for each sentence. This method of treatment could be seen as being more explicit, elaborated, and focused than other measures that employed visual enhancement alone. As such the various combinations of treatments, which could have led to greater degrees of saliency or noticing, need to be taken into account when evaluating the effects of these studies.

Secondly, the studies utilized varying measures of assessing the degrees of noticing. Studies that did use some form of a noticing measure provided some intriguing evidence as to the degree and nature of noticing that took place. However, the types of noticing induced in the various studies seemed to have differential effects and to have triggered diverse types of attention/memory processing. For example, White's (1998) study indicates that many learners noticed the targeted forms but they were not sure of their relevance or importance. This may account for the limited benefits of the treatment by the enhanced input group in her study. On the other hand, Alanen's (1995) study found that noticing seems to be an important factor in accounting for the subsequent learning of the target form by her participants. However, the cross-comparison of the learning outcomes and noticing results suggests that noticing appears to have been induced by a variety of factors, not the least of which was input enhancement. The use of a noticing measure or multiple measures of noticing could rectify this lack of consistency in future studies.

A third problem in the studies involves the issue of learner readiness or the students' developmental level vis-à-vis the target form. As Pienemann (1984) suggests the effect of any given pedagogical treatment could be constrained by the student's developmental readiness. Only two of the studies (Doughty, 1991; White, 1998) provided any measure of assessing the learnability of the targeted form for the given group of learners prior to the start of the treatment. This may account for why specific treatments had little or no facilitative effects on specific groups of learners. As Han (2003) emphasizes, only by gauging learners' degree of readiness prior to the treatment can the full effects of the treatment be evaluated.

DISCUSSION

In order to fully explore the effects of Input Enhancement upon the learner's cognitive processing system, we must return to the framework provided initially by Sharwood Smith (1993) in his rationale behind Input Enhancement. Sharwood Smith (1993) wished to facilitate the learner's selection process of input by increasing the perceptual saliency of specific targeted forms in the input. This process would appear to engage the learner's attention as a selective process as it involves directing the learners' focal attention to a specific form from an array of verbal or written forms. Another point Sharwood Smith (1993) emphasizes in his rationale for Input Enhancement is the possibility of increasing the saliency of a selected form in order to promote the restructuring of a the learners developing interlanguage system. This would seem to involve not only the process of selective attention, but also the way in which the form is to be subsequently processed by the working, short-term memory and long-term memory. In the case that the learner selects the highlighted form, one of two possible courses is available to lead to further processing: mechanized rehearsal or elaborative rehearsal. Thus, at this level, input enhancement, needs to be examined in light of the interface between memory and attention. Finally, capacity constraints, which mediate the levels of attention available for processing, need to be considered.

Does input enhancement trigger the function of attention as selection?

Although it is difficult to accurately determine the levels of selective attention that the treatments in the previous studies of Input Enhancement promoted, it nevertheless appears that a form of focal attention was paid to the textual enhancement in some of the previous studies. In two of the studies (Alanen, 1995; Jourdenais et al., 1995), by using post treatment think aloud protocols, the researchers concluded that the participants paid some form of focal attention to the input. One problem inherent in their use of think aloud protocols, is that the participants were describing their thought processes post-task, *off-line*. As Leow (2000, 2001) argues such measures are of somewhat limited value as they require the learners to go back and describe short durational thought processes. In order to counteract this problem, Leow (2000, 2001) conducted *on-line* think aloud protocols, during which the subjects recorded while engaged in the task. This form of thought processes collection while illuminating poses another dilemma as the actual act of performing the on-line measure could distract the participants from performance of the treatment task. These reservations aside, in all three cases (Alanen, 1995; Jourdenais et al., 1995; Leow 2001), the participants did report varying levels of noticing the enhanced form. At this initial level of processing, focal attention appears to have been operative in the learners' selection of input.

Does input enhancement affect the interface between attention and memory?

In Robinson's (1995, 2001a, 2001b, 2003) account of attention and memory, the processing of information from the working memory to the long-term memory involves two types of rehearsal: elaborative rehearsal and maintenance rehearsal. In the one of the longer term studies of Input Enhancement (Doughty, 1991), the effects of elaborative rehearsal may have led to her participants' greater success on the post-treatment written tasks. Because the researcher employed a variety of tasks in addition to input enhancement, it is difficult to ascertain just what long-term memory effects Input Enhancement alone had upon the participants. Nonetheless, one could argue that the very presence of multiple forms of input could trigger the cognitively higher-level elaborative rehearsal process. As elaborative rehearsal involves the activation of the learner's previous knowledge or schemata, it appears that a study that employs a variety of more explicit, semantic processing tasks (such as reading for meaning) in addition to Input Enhancement could promote better long-term memory of targeted forms.

Some of the other Input Enhancement studies (Leow 2001; Jourdenais et al., 1995; White, 1998; Robinson, 1997), which attempted to introduce a targeted form, may have had less positive effects due to the learners' lack of a store of previous knowledge into which the new information could be encoded. White's (1998) study in particular emphasized the fact that even after repeated, long-term exposure to multiple Input Enhancement treatments, her participants still did not know precisely why the targeted forms were being highlighted. This indicates that exposure to new forms via Input Enhancement alone might only activate the maintenance rehearsal process, during which the newly encoded input is stored in the long-term memory as an unanalyzed chunk. As much second language learning involves chunking new information into the long-term memory, perhaps future studies of this kind could attempt to utilize a variety of treatments (both explicit and implicit), to allow for greater moments of learner analysis. In isolation, Input Enhancement may not promote conceptually driven learning processes. However, well-timed treatments, which promote a combination of data-driven learning in conjunction with subsequent conceptually driven learning, could yield more robust outcomes.

How do capacity constraints of attentional resources affect input enhancement?

The capacity constraints of attentional resources play a vital mediating role in determining the outcome of Input Enhancement treatments. In some cases, researchers have argued that tasks that involve a higher level of attention lead to higher levels of cognitive processing than Input Enhancement (see Leow, 2000). While this may be the case, as previous research has shown (Robinson, 2001a, 2001b), if a task is too demanding, the learners will have not have adequate attentional resources remaining to attend to the targeted form. As an alternative, Doughty (2001) highlights the possible importance of roving attention in tasks that place simultaneous demands on the learner. Roving attention, she speculates, because it is susceptible to stimuli and influence, which is outside focal attention, could be engaged to concentrate on form while selective attention processes meaning. However, no means, as yet, have been devised as a way to harness the power of roving attention.

CONCLUSION

The research on input enhancement and cognitive processing is still at a very early stage. Nevertheless we can see that input enhancement does engage the learners' focal attention processes and it does lead to subsequent processing of varying degrees of depth. In order to better understand input enhancement, future research should take into account some of the issues highlighted here. The effect of input enhancement in conjunction with other concurrent tasks needs to be studied more fully in order to better understand issues of timing and capacity. Likewise, longitudinal studies that employ multiple treatments could better gauge how input enhancement activates the learners' cognitive processes especially in the long-term memory. Clearly memory structures are capacity limited and impose constraints on attentional processes. However, it is still unclear as to what learning processes these structures and constraints give rise to. Hopefully as research data accumulates in this field we will have a clearer understanding of how individual variation in attention, memory, and rehearsal affects second language learning.

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