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How effective are recasts? The role of attention, memory, and analytical ability

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Introduction

Language is a complex cognitive skill, and its complete mastery requires extended amounts of experience and practice. (For review, see Tomasello 1998.) Learning a second (or subsequent) language is clearly no exception. Indeed, second language (L2) learners' speech and writing are often characterized by a great number of errors (Lightbown and Spada 1990; 1994). These errors reveal the complex nature of L2 learning and suggest that many learners may fall short of native-like L2 mastery (DeKeyser 2000), often notwithstanding what are believed to be the 'optimal' conditions for L2 development: availability of comprehensible input and an emphasis on the communication of meaning (Long 1996; Gass 2003). Why are some learners unable to take advantage of their exposure to often rich, contextualized, and meaningful input? In the study reported in this chapter, we sought to explain learners' difficulties in L2 learning in terms of individual differences, those related to learners' attention, memory, and language aptitude. To this end, we examined the role of four cognitive processing factors—phonological memory, working memory, attention control, and analytical ability—in determining the effectiveness of recasts. Our goal was to examine the extent to which individual differences influence learners' ability to notice and benefit from recasts.

Recasts and L2 development

Defined as discourse moves that 'rephrase [a learner's] utterance by changing one or more sentence components [...] while still referring to its central meanings' (Long 1996: 434), recasts are believed to promote L2 development in the context of meaningful interaction. As argued by Long in his discussion of the Interaction Hypothesis (Long 1996), recasts are considered to be effective in promoting L2 development because they (as well as other types of interactional feedback) often occur in reaction to communication breakdowns in L2 interaction. In such cases, recasts are believed to offer learners both negative feedback (by reformulating a non-target utterance) and positive input (by modeling the intended targetlike utterance) about their problematic production (Leeman 2003). Recasts appear to promote L2 development, at least in part, because they draw learners' attention to the discrepancy (the 'gap') between the target linguistic system and the learners' own conception of it (Rutherford and Sharwood Smith 1985; Schmidt 1990; 2001; Long 1991), precisely at the time when learners are negotiating for meaning. Often described as an ideal interactional feedback technique (Long 2006, but see Lyster 1998b), recasts are appealing because, first, they are implicit and unobtrusive (i.e. they highlight the error without breaking the flow of communication) and, second, they are learner-centered (i.e. their use is contingent on the meaning that the learner is trying to communicate). In fact, recasts appear to be one of the most common interactional moves documented in both L1 discourse (Hirsch-Pasek, Treiman, and Schneiderman 1984; Demetras, Post, and Snow 1986) and in L2 communication (Lyster and Ranta 1997; Braidi 2002).

One question central to the Interaction Hypothesis pertains to investigating the effectiveness of recasts in promoting L2 development. To date, two approaches have largely been used to answer this question. The first approach has been to document the extent to which learners notice recasts. Measuring the 'noticeability' of recasts is important because the outcomes of interactional modification, triggered by recasts, might crucially depend on learners' noticing either the negative feedback or the positive input (or perhaps both) available in recasts. (See Leeman 2003 for further details on this issue.) Several studies have looked at the noticeability of recasts, measuring this construct in terms of learners' modified responses (incorporations) following recasts (Mackey and Philp 1998; Braidi 2002), learners' retrospective recall (Mackey, Gass, and McDonough 2000; Mackey, Philp, Egi, Fujii, and Tatsumi 2002), cued immediate recall (Philp 2003), and their online visually cued discrimination accuracy (Ammar, Trofimovich, and Gatbonton 2006). The second approach to investigating the effectiveness of recasts has been to examine either the immediate or delayed benefits of recasting for learners' accuracy in the context of L2 interaction. The studies that have used this approach overall have documented positive effects of recasting on L2 development (Doughty and Varela 1998; Long, Inagaki, and Ortega 1998; Mackey and Philp 1998; Leeman 2003; Ammar and Spada 2006).

The effectiveness of recasts, however, appears to be qualified by several factors. One factor is the linguistic structure targeted by recasts. Thus, for example, learners (particularly those at a low proficiency level) have been shown to notice fewer morphosyntactic than lexical errors targeted by recasts (Mackey *et al.* 2000; Ammar *et al.* 2006) and to benefit more from recasts targeting some L2 structures than others (Long *et al.* 1998). Another factor is the learners' L2 proficiency level. For example, high and intermediate proficiency learners appear more likely than low proficiency learners to notice recasts (Philp 2003) and to modify their production in response to them (Mackey and Philp 1998; Ammar and Spada 2006). More importantly for the purposes of this study, learners' ability to notice recasts also appears to depend on their phonological and working memory, the only cognitive factors investigated to date in the context of L2 interaction. Mackey *et al.* (2002) showed that learners with larger working and phonological memory spans tend to be more likely to notice recasts than learners with smaller spans. No study known to us has to date examined whether cognitive (processing) factors, those related to learners' attention, memory, and language aptitude, also influence learners' ability to benefit from recasts.

Taken together, the findings reported above reveal possible constraints on the effectiveness of recasts, thereby suggesting some limitations of recasting as an interactional feedback technique. More importantly, these findings underscore the importance of research into the effectiveness of recasts as a function of individual differences, not only differences in learners' age (Mackey and Oliver 2002) and proficiency (Philp 2003) but also possibly those in learners' attention, memory, and language aptitude. This research agenda is compatible with recent calls to relate L2 development to cognitive processes underlying it. (For a review, see Robinson 2002a.) The purpose of the study reported in this chapter was therefore to investigate the extent to which learners notice and benefit from recasts as a function of four cognitive factors: phonological memory, working memory, attention control, and analytical ability.

Cognitive factors and recasts

The choice of the factors investigated here in relation to learners' ability to notice and benefit from recasts was prompted by their likely involvement in L2 learning, particularly in the context of oral interaction. In his information-processing model, Skehan (2002) describes several L2 acquisition stages and identifies the cognitive processing skills required at each stage. According to Skehan, *noticing* (Stage 1) calls for skills in auditory speech segmentation, attention management, working memory, and phonemic coding. In turn, *pattern identification* (Stage 2) draws on working memory skills and grammatical sensitivity (analytical ability). If learners' processing of recasts entails the ability to notice, identify, and compare patterns of language, then the skills associated with the noticing and pattern identification processing should determine the degree to which learners can notice and ultimately benefit from recasts.

How can the cognitive factors underlying the noticing and pattern identification stages in Skehan's framework—working memory, phonological memory, analytical ability, and attention control—influence the degree to which recasts are noticed and used? The first of these factors, working memory, underlies an individual's ability to simultaneously process and store verbal information relevant to the processing task at hand. (For a review, see Miyake and Friedman 1998.) In previous research, working memory has been shown to relate to learners' performance on tests of L2 grammar, vocabulary, and reading (Harrington and Sawyer 1992) as well as to learners' oral ability (Geva and Ryan 1993). In the context of L2 interaction, working memory may delimit the amount of verbal information learners can simultaneously attend to, thus defining the extent to which recasts are registered (Mackey *et al.* 2002), processed, and ultimately acted upon.

The second factor, phonological memory, refers to an individual's capacity to retain spoken sequences temporarily in a short-term memory store. This capacity is usually associated with the 'phonological loop', a subcomponent of the human working memory system responsible for temporary storage of verbal-acoustic information. (For a review, see Baddeley, Gathercole, and Papagno 1998.) Phonological memory has been found to be a strong predictor of learners' ability to repeat (Service 1992) and eventually learn (Gathercole and Baddeley 1990) new words, suggesting that there is a causal relationship between phonological memory and L2 vocabulary learning. Other evidence has implicated phonological memory in L2 grammar development as well. O'Brien, Segalowitz, Collentine, and Freed (2006), for example, demonstrated that phonological memory explained 16 per cent of the unique variance in L2 Spanish learners' use of grammar in spoken narratives. (See also N. Ellis and Sinclair 1996.) In the context of L2 interaction, phonological memory may influence the degree to which learners are able to encode and retain, in their short-term phonological memory store, the information available in recasts and to make this information available for further analysis.

The third factor, analytical ability, typically describes an individual's sensitivity to grammatical structure. (See Skehan 2002 for a review.) Several studies have to date reported associations between analytical ability and L2 development. Harley and Hart (1997) found that analytical ability was significantly associated with adolescent learners' L2 proficiency measures, including morphosyntactic accuracy rates. Similarly, Ranta (2002) and DeKeyser (2000) both reported a link between morphosyntactic development and analytical ability in younger and older learners, respectively. If analytical ability has a role to play in L2 interaction, it likely defines learners' capacity to identify and focus on the structural properties of their own speech and the speech addressed to them (for example, in the form of a recast). This capacity may affect learners' success in noticing the elements targeted by a recast and, ultimately, in benefiting from this information.

The final factor examined here in relation to learners' ability to notice and benefit from recasts is attention control, or the ability to efficiently allocate attention among different aspects of language or different cognitive processing tasks. (For a general review, see Schmidt 2001.) As a cognitive construct, attention control involves a number of functions associated with a variety of neurobiological structures (Posner 1995). When applied to language, attention control may refer to enhanced processing of the linguistic stimuli that are relevant to the task at hand and to inhibited processing of the stimuli that are irrelevant to it (Eviatar 1998). Attention control may also refer to an individual's ability to shift attention efficiently among different sets of linguistic relationships (Talmy 1996). In one study that established a link between linguistic attention control and L2 proficiency, Segalowitz and Frenkiel-Fishman (2005) showed that English-French bilinguals' ability to efficiently allocate attention between two sets of linguistic targets (temporal versus causal) in their L2 explained 32 per cent of the unique variance in these same bilinguals' French (L2) proficiency (defined as efficient lexical access). In other words, these bilinguals' ability to efficiently switch attention among several aspects of their L2 had an independent contribution to predicting the same bilinguals' L2 proficiency. In the context of L2 interaction, attention control may influence how well learners can attend to different aspects of linguistic information available in a recast or how well learners can switch their attention among different cognitive tasks in which they are (nearly) simultaneously engaged (for example, perceiving a recast and subsequently encoding their own message). In either case, efficient attention control should lead to learners' ability to notice and benefit from recasts.

The present study

To examine whether learners' ability to notice and benefit from recasts depends on individual differences in learners' working memory, phonological memory, analytical ability, and attention control, we tested Francophone learners of English as a second language (ESL) on several tasks. First, the learners performed an online picture description task. In this task, they described simple drawings whose descriptions elicited a particular feature of the L2 (described below). They heard corrective feedback (recast) about each description, indicated whether they noticed the feature targeted by the recast, and described each drawing again. Because learners' ability to notice and benefit from recasts might be related to the type of L2 feature targeted by a recast (Mackey *et al.* 2000), we used three types of L2 features as targets: morphosyntactic (English possessive determiners), lexical (intransitive verbs), or both (transitive verbs followed by a possessive determiner/noun combination). Because it is important to assess the effectiveness of recasts as a function of when learners receive it (Mackey and Philp 1998), we tested learners immediately after the recast was heard (in the immediate turn) and after a 2–12 minute delay. Following the treatment and tests, the learners then completed four more tests: (1) a test of phonological memory measuring phonemic coding skills, (2) a test of working memory measuring the executive function of working memory, (3) a test of attention control measuring executive attention management, and (4) a test of analytical ability measuring grammatical sensitivity.

Because phonological memory, working memory, analytical ability, and attention control are complex cognitive constructs, representing a cluster of different processing skills (see Robinson 2002a for a review), we hypothesized that learners with relatively larger phonological memory, more extensive working memory spans, more efficient attention control, and stronger analytical ability would be more likely to notice the feature targeted by the recasts, and to use the recast form in subsequent picture descriptions than learners with weaker attention, memory, and analytical ability skills. The assumption was that learners with weaker attention, memory, and analytical ability would have difficulties in processing and encoding incoming information in the recasts in memory, in efficiently switching their attention among different aspects of language or among several cognitive tasks (for example, perceiving a message and encoding their own message), and in focusing on the structural properties of their own speech and the speech addressed to them.

Method

Participants

The participants in this study were 32 adult Francophones (24 females, eight males) residing in Québec (mean age: 30.4, range: 19–54). All were native speakers of French who were born and raised in monolingual French homes in France (four) or in Québec (28). All had received primary and secondary education in French and all reported using French as the only home language. With the exception of three, whose first exposure to English occurred in their early 20s or 30s, the participants started learning English as children at an average age of 9.7 as part of primary ESL instruction in Québec, and had studied English on average 45 minutes per week in elementary school, 75 minutes per week in high school, and 180 minutes per week in junior college. Prior to testing, the participants (henceforth, the learners) estimated their daily use of French and English on a 0–100 per cent scale. These self-ratings indicated that the learners on an average daily basis used French 86 per cent of the time (range: 50–100, SD = 5.3) and English the other 14 per cent of the time (range: 0–80, SD = 3.2).

A speaking task was administered to obtain a measure of the learners' L2 proficiency. In this task, the learners spoke extemporaneously for about two minutes in English in response to a simple prompt ('Talk about one frightening experience in your life.'). The learners were recorded using a Sony TCM-200DV portable recorder; their speech was later transcribed. Three measures were derived from the recorded samples. Speech rate, a fluency measure, was calculated by dividing the number of uttered words by the total duration of the sample, which included pauses and hesitations, yielding a speech rate ratio (words per second). Durations were measured to the nearest millisecond from the display of digital speech-analysis software (*CoolEdit 2000*). Proportions of lexicosemantic and morphosyntactic errors were the two accuracy measures, computed by dividing the number of words containing an error of each type by the total number of words in the sample. Errors in sentence structure, morphology, and syntax (for example, article use, word order, tense/aspect) were classified as morphosyntactic errors. Inappropriately used lexical items (including French words) were classified as lexical errors.

Results of these analyses revealed that the learners on average produced 24 words (18 per cent) containing errors (*SD*: 19.4; range: 4–77) and spoke at an average rate of 1.5 words per second (*SD*: .60; range: .53–2.82). Of the total number of words containing errors, 11 words (seven per cent) on average contained morphosyntactic errors (*SD*: 8.31; range: 1–36), 13 words (11 per cent) contained lexicosemantic errors (*SD*: 13.04; range: 1–52). The accuracy scores (number of words with each error type over the total number of words) ranged from .02–.14 (*SD* = .03) for morphosyntactic errors and from 0–.48 (*SD* = .12) for lexicosemantic errors. These accuracy scores suggested that the learners represented a range of L2 ability levels.

Tasks

The testing, which lasted approximately 90 minutes, was conducted individually in a quiet location using a personal computer. The researcher, a French–English bilingual, gave testing instructions in French. The learners performed several tasks (described in detail below). A schematic representation of the tasks used appears in Figure 7.1.

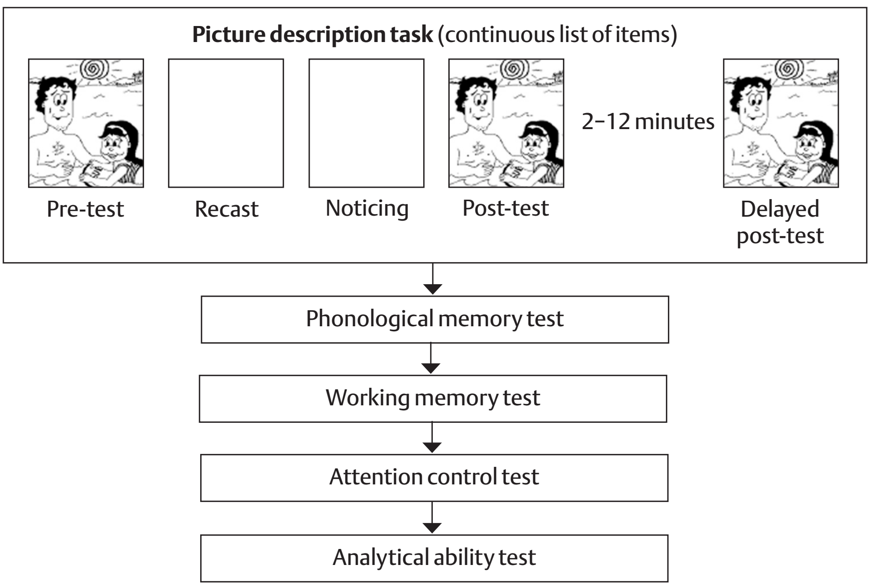

Figure 7.1 Schematic representation of the tasks used in this study

Picture description

Operationalization

Recasts are defined as reformulations of learners' non-targetlike utterances that are contingent on learners' errors (Long 1996; Mackey and Philp 1998). However, the design of the running picture description task used in this study required that the learners received digitally recorded native speaker responses after all of the learners' picture descriptions, which ranged in accuracy from 4–85 per cent correct ($SD = 22$). Thus, for example, if the learners made an error in their picture description (*'He is scratching the back'), the response ('Yeah, he is scratching his back') 'acted' as a recast targeting an erroneous production. However, if the learners produced the expected picture description accurately ('He is scratching his back'), the response was effectively a repetition of their targetlike production. To ensure that the results of this study are comparable to previously reported findings (c.f., Mackey and Philp 1998), in the critical analyses conducted as part of this study (i.e. analyses of recast noticeability), we distinguished between the provided native speaker responses that were 'true' recasts and those that were repetitions. In other words, the data reported below were computed for each individual learner, where appropriate, as proportions based on the total number of that learner's *non-target utterances* only. By definition, then, the responses given to learners in these cases (in reply to their non-target utterances) were recasts. Although recasts defined in this way may not fully generalize to reactive, spontaneous language use in the course of person-to-person interaction (a point which we revisit below), this conceptualization of recasts allowed us to investigate the effectiveness and noticeability of recasts within the confines of a controlled laboratory-based language processing study.

Task materials

The materials used in the picture description task consisted of 96 simple line drawings depicting members of two families, each consisting of one male and one female child, their parents and grandparents, all engaged in ordinary daily activities such as playing, eating, brushing teeth, etc. Of these 96 drawings, 48 were designated as experimental drawings and 48 as distractors. The 48 critical items were constructed by pairing each experimental drawing with a question-recast sequence. There were three types of linguistic targets: 24 grammar targets, 12 lexical targets, and 12 'mixed' targets. The grammar targets elicited English possessive determiners ('his', 'her'; henceforth PDs) in the context of their use with human body parts ('his head', 'her leg') and with kin-different animate nouns ('his mother', 'her brother'), with 12 items in each set ('He is washing his face', 'She is talking to her brother'). These contexts represented the cases of PD use that are most problematic for Francophone learners of English (White 1998). PDs agree in gender and number with the determined noun (*sa mère* ['his mother'], *sa* = fem.) in French (Grevisse 1993). By contrast, in English they agree with the possessor ('his mother', 'his' = masc.) and are invariant in the number and gender of the noun they determine (Quirk, Greenbaum, Leech, and Svarvik 1972). The 12 lexical targets elicited English intransitive verbs ('She is yawning'). The 12 'mixed' targets elicited English transitive verbs (lexical targets) in conjunction with PDs (grammar targets) used with human body parts ('He is scratching his back'). The three linguistic targets and sample question-recast sequences used with each target appear in Table 7.1. The distractors were comparable line drawings that elicited English transitive verbs ('She is reading a book') and English PDs used with kin-same animate nouns ('He is playing with his brother'), a context in which PD use in English and French overlaps.

Item type	**Materials**	
	Question	**Recast**
Grammar (body parts)	What is he washing?	Yeah, he is washing his face.
Grammar (kin-different)	Who is she talking to?	Yeah, she is talking to her brother.
Lexical	What is she doing?	Yeah, she is yawning.
Mixed	What is he doing?	Yeah, he is scratching his back.
Filler (kin-same)	Who is she playing with?	

Table 7.1 Sample item materials used in the picture description task

Task procedure

The questions and recasts associated with each drawing were digitally recorded by a male native English speaker. Each of the 48 critical items (drawings and sound files), 48 distractors, and 24 repeated critical items (discussed below) were organized in a continuous randomized list of four–event sequences, presented using the DMDX software developed by K. I. Forster and J. C. Forster at the University of Arizona. There were four such randomized 120-item experimental lists to which learners were assigned randomly. (See Figure 7.2 for a schematic representation of a sample sequence. The example depicted in Figure 7.2 illustrates a four–event sequence for a kin-different grammar target.)

The first event in each sequence was a *pre-test*. Here the learners saw a drawing and, approximately 2.5 seconds after it appeared on the screen, heard a question about the drawing ('Who is he swimming with?') to which they had to respond using a simple sentence, which could be either correct ('He is swimming with his daughter') or incorrect (*'He is swimming with her daughter'). The drawing was displayed for five seconds. The second event was a *recast*. Here the learners heard the expected picture description ('He is swimming with his daughter'). The third event was *noticing*. Here the learners were prompted to indicate, by saying 'yes' or 'no', whether they noticed any difference between their own original description and the description played back to them ('Did you notice any difference? Please say yes or no'). The fourth event was a *post-test* in which the learners saw the same drawing again and heard the same question to which they had to respond again using a simple sentence.

The final event in each sequence was a *delayed post-test*. Twenty-four critical items (six items randomly selected from each linguistic target set, resulting in 24 unique items in each of the four 120-item lists) were designated to be repeated and used as delayed post-test. These items (drawings and sound files) appeared again after at least four but no more than 24 intervening items (i.e. with a 2–12 minute delay, on average) following their original presentation. Here the learners saw the drawing and described it in response to the question heard (Figure 7.2). Both the post-test and the delayed post-test were included to examine the extent to which the learners were able to 'act' on their noticing of the recast heard, that is, to be able to use the correct form provided in the reformulation. The 48 distractors, representing picture descriptions not followed by a recast and a noticing question, were randomly inserted between critical items.

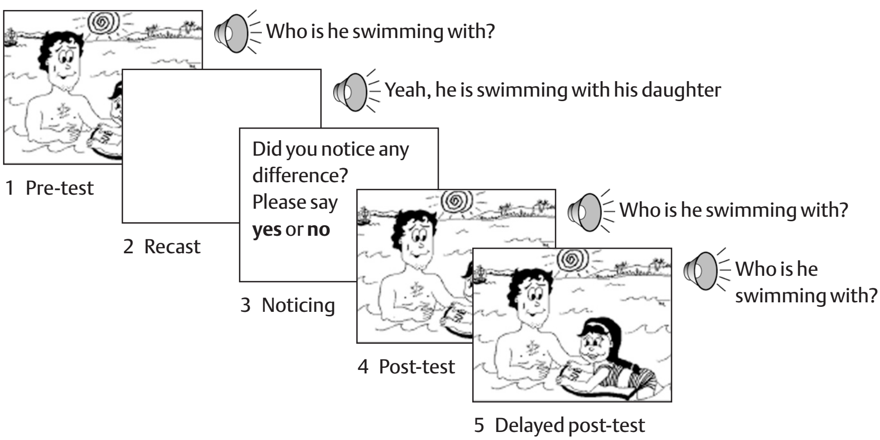

Figure 7.2 Schematic representation of a sample sequence in the picture description task

Prior to testing, the learners were familiarized with the family relationships of the characters depicted in the drawings. All learners were able to pass a simple test in which they were asked to name the relationships ('brother', 'mother', etc.) among the family members. The learners were then informed that they were taking part in a picture description experiment. Their task was to give a one-sentence description of each drawing in response to the auditorily presented question and, for the critical items, to indicate (by saying *yes* or *no*) whether they noticed any difference between their picture descriptions and those that they had just heard. The learners initiated each subsequent trial by pressing the space bar on the computer keyboard. The entire session was recorded (using a Sony TCM-200DV portable recorder) and later analyzed.

Data coding

Four measures were derived for each learner in the picture description task. Three were measures of production accuracy, defined for each learner as the proportion of correctly produced linguistic targets of the same type (grammar, lexical, mixed). These scores were calculated separately for the drawings presented in pre-tests, post-tests, and delayed post-tests. A picture description was scored as '1' if the learner produced the correct PD-noun combination (in response to grammar targets), the verb (in response to lexical targets), or both (in response to mixed targets), and was scored as '0' if the learner failed to do so. Errors unrelated to the linguistic targets were disregarded. A score of '0.5' was assigned to a picture description (in response to mixed targets) if the learner produced correctly only the verb or the PD-noun combination, but not both ('He is cleaning his teeth' or 'He is brushing the teeth' in place of 'He is brushing his teeth'). The fourth measure was the proportion of noticing, computed by dividing, for each learner, the number of correctly detected non-target descriptions by the total number of non-target descriptions. Non-target descriptions were defined as those that mismatched the provided description by the linguistic target only (PD, verb, or both). In other words, the descriptions that mismatched the expected descriptions in any other way (i.e. by a form that was not targeted in this study or by *more than one* form) were not considered in the calculation of the noticing score. These descriptions were excluded because the noticing responses based on such descriptions could not be unambiguously attributed to accurate detection of the targeted error only. The proportions of non-target descriptions ranged between .15 and .96 (SD = .22) for individual learners.

Phonological memory

A serial non-word recognition task was used as a measure of phonological memory. A non-word recognition task, as opposed to widely used non-word repetition tasks or recall tasks involving words and non-words, appears to minimize lexical (vocabulary knowledge) influences on phonological memory, yielding a relatively accurate estimate of phonological memory. (For theoretical justifications, see Gathercole, Pickering, Hall, and Peaker 2001.) English non-words (i.e. non-words that adhered to English phonotactics) were used in this task to assess the learners' ability to encode and temporarily access auditory sequences in their L2. In this task, the learners judged whether two consecutively presented sequences of pronounceable English non-words were in the same or in a different order.

Task materials

The materials consisted of 160 one-syllable CVC non-words taken from Gathercole *et al.* (2001). The non-words were digitally recorded by a male native English speaker. They were organized into sequences of four, five, six, and seven items. There were four pairs of non-word sequences of four items, and eight pairs of non-word sequences of five, six, and seven items in each, for a total of 28 pairs of non-word sequences. All items within a sequence had a different vowel sound, and the consonant composition within each sequence was as distinctive as possible. Half of the sequence pairs of each length contained identical sequences. That is, the second sequence in each pair was identical to the first sequence (for example, 'loog jahl deech kerm meb … loog jahl deech kerm meb', where ellipses indicate a short pause). The other half of the sequence pairs of each length contained different sequences. Although the items within the two sequences were identical, one pair of items was transposed in the second sequence, with the constraint that the first and last pair of items were never transposed (for example, 'lod tudge jick norb garm … lod tudge norb jick garm'). This constraint reduced the salience of transposed items and encouraged the learners to process the complete stimulus sequence. The location of the transposed pair was varied randomly across sequence lengths.

Task procedure

The 28 non-word sequences were presented using speech presentation software (Smith 1997) over computer speakers, with the four four-item sequence pairs presented first, the eight five-item sequence pairs presented next, followed by the eight six-item sequence pairs and, finally, the eight seven-item sequence pairs. The non-words were presented at the rate of one item every 800 milliseconds, with a 1.5 second pause between the two sequences in each pair. Upon hearing each sequence pair, the learner indicated, by clicking one of the buttons labeled 'same order' and 'different order' on the computer screen, whether the two sequences were presented in the same or a different order. The learners had unlimited time to provide their judgment but were not permitted to replay the sequence or to change their response. Before testing, the learners were given two same and two different sequence pairs as practice. The number of correct responses (out of 28) was recorded and used as a measure of phonological memory.

Working memory

The learners' working memory was assessed using the Letter–Number Sequencing subtest from the Wechsler Adult Intelligence Scale—WAIS-III (Psychological Corporation 1997). Because this task, validated in both normal and brain-injured populations (Donders, Tulsky, and Zhu 2001), presumably requires the learners to manipulate information online, the task is sensitive to measuring the processing and executive aspects of working memory (Myerson, Emery, White, and Hale 2003). In this test, the learners heard a series of numbers and letters and then recalled the numbers in numerical order followed by the letters in alphabetical order. This task was administered in the learners' L1 (French) because working memory capacity likely represents a general (as opposed to language-specific) ability to simultaneously store and process incoming information (Osaka, Osaka, and Groner 1993).

Task materials and procedure

The stimuli consisted of French letters (A–Z) and digits (1–9), digitally recorded by a female native French speaker. The digits and letters were organized into sequences of two to eight items, with three sequences of each length, for a total of 21 sequences. The 21 letter–digit sequences were presented using speech presentation software (Smith 1997) over computer speakers. The three two-item sequences (one number, one letter) were presented first (for example, *L* … *deux* [two]), followed by the three sequences at each consecutive length, with the three eight-item sequences (four numbers, four letters) presented last (for example, *cinq* [five] … *H* … *neuf* [nine] … *S* … *deux* [two] … *N* … *huit* [eight] … *A*). The digits and letters were presented at the rate of approximately one per second. Upon hearing each sequence, the learner had to report the presented sequence orally first by naming the digits in ascending numerical order followed by the letters in alphabetical order. For example, the expected responses for the sample sequences given above were *deux* … *L* and *deux* … *cinq* … *huit* … *neuf* … *A* … *H* … *N* … *S*. The test continued until the learner failed to produce the correct response for all three trials of a given sequence length. The number of correct responses (out of 21) was recorded and used as a measure of working memory.

Attention control

Task materials and procedure

The Trail Making Test, originally designed as part of the US Army Individual Test Battery (1944), was used to estimate attention control. The test appears to provide a language-neutral estimate of an individual's ability to shift attention between two sets of stimuli (Lee, Cheung, Chan, and Chan 2000). The test consists of two parts and involves drawing a line to connect consecutive digits from 1 to 25 (1—2—3—4—5—6, etc.) in Part A and drawing a similar line to connect alternating digits and letters (1—A—2—B—3—C, etc.) in Part B. Assuming that the time it takes to complete a non-alternating digit sequence (Part A) provides the baseline for each individual's motor and visual control, the additional cost imposed on the individual by the alternating digit–letter sequence (Part B) provides a measure of this individual's executive control, or the ability to switch attention between two stimulus sequences. In other words, the difference in completion time between Part B and Part

A of the test is indicative of the individual's attentional control of switching between different stimuli (Corrigan and Hinkeldey 1987) and between different cognitive tasks (Arbuthnott and Frank 2000).

For all learners, Part B of the test followed Part A, each preceded by an eight-item practice session. The completion times for both parts of the test were measured using a digital stopwatch and were recorded in seconds, with the values rounded to the nearest one hundredth of a second. The difference in completion times between Part B and Part A of the test, which were moderately correlated ($r = .48$, $p = .005$), was used as a measure of attention control. A smaller score, corresponding to a smaller difference in completion time between Part B and Part A of the test, represented more efficient attention control.

Analytical ability

Task materials and procedure

Analytical ability was assessed using Part IV of the Modern Language Aptitude Test (Carroll and Sapon 1958, French translation). The French version of the test was used to obtain a measure of analytical ability that was independent of L2 knowledge. Part IV of the test assesses the ability to understand the function of words and phrases in sentences, a measure of what is often termed as sensitivity to grammatical structure or capacity to focus on the structural properties of linguistic input (Ranta 2002; Skehan 2002). In this test, the learners read 31 pairs of sentences (*Ottawa est la capitale du Canada* [Ottawa is the capital of Canada], *Elle aime aller pêcher en Gaspésie* [She likes to go fishing in Gaspésie]) and indicated, by circling the appropriate choice, which of the underlined words in the second sentence (*Elle*) performed the same grammatical function as the underlined word in the first (*Ottawa*). The number of correct responses (out of 31) was used as a measure of analytical ability.

Results

For all analyses reported below, the alpha level for significance was set at .05 and was adjusted for multiple comparisons, where appropriate, using the Bonferroni correction. The reported effect sizes are partial eta squared (η_p^2), calculated by dividing the effect sum of squares by the effect sum of squares plus the error sum of squares.

Noticeability of recasts

The learners' noticing scores for each set of linguistic targets (grammar, lexical, mixed) were submitted to a one-way repeated-measures analysis of variance (ANOVA), which yielded a significant F ratio, $F(2, 62) = 8.27$,

p <.001, η_p^2 = .21. Tests exploring the significant F ratio (Bonferroni corrected α = .017) revealed that the learners were statistically significantly more accurate at detecting a mismatch in lexical than in grammar targets following recasts (p < .001). There was also a tendency for the learners to be more accurate at detecting a mismatch in the mixed than in the grammar targets following recasts. This latter difference was, however, not significant after the Bonferroni correction (p = .032). These findings suggest that, when the learners made errors and then received recasts, they detected fewer morphosyntactic than lexical (verb) mismatches between their own descriptions and those provided to them. The learners' mean noticing accuracy is summarized in Table 7.2.

Target	**Number of targets**	**Range of recasts received**	**Noticing accuracy**	**Range of noticing accuracy**
Grammar	24	0–23	84.84 (19.31)	41–100
Lexical	12	4–12	96.94 (06.53)	73–100
Mixed	12	0–12	92.66 (12.62)	50–100

Table 7.2 Number of linguistic targets, ranges of recasts received, means and ranges of noticing accuracy (per cent correct) as a function of target (standard deviations appear in parentheses)

Effects of recasts

The learners' production accuracy was submitted to a two-way repeated-measures ANOVA with test (pre-test, post-test, delayed post-test) and target (grammar, lexical, mixed) as within-subjects factors. This analysis yielded significant main effects of test, $F(2, 62) = 186.30$, $p < .0001$, $\eta_p^2 = .86$, and target, $F(2, 62) = 24.55$, $p < .0001$, $\eta_p^2 = .44$, and a significant interaction, $F(4, 124) = 28.66$, $p < .0001$, $\eta_p^2 = .48$. Tests of simple main effects conducted to explore the significant interaction (Bonferroni corrected α = .002) revealed that, for all targets (grammar, lexical, mixed), the learners were statistically significantly more accurate on the post-test than on the pre-test and the delayed post-test, and that they were statistically significantly more accurate on the delayed post-test than on the pre-test (all ps < .0001). This finding suggests that, regardless of the target, the learners overall benefited from a recast immediately after it was given (on the post-test) and sustained this benefit over a short delay (on the delayed post-test).

Tests of simple main effects also revealed that the obtained significant target × test interaction was due to different accuracy rates on the pre-test. On the pre-test, the learners were statistically significantly more accurate at producing grammar targets than they were at producing lexical and mixed targets. The learners were also statistically significantly more accurate at producing mixed targets than they were at producing lexical targets (ps < .0001). This finding suggests that prior to receiving a recast, the learners were more accurate at correctly using English PDs in their picture descriptions than they were at using verbs. This finding likely reflected the learners' initial unfamiliarity with the (relatively low-frequency) verbs used as lexical and mixed targets ('slide', 'scratch', 'pluck', 'parachute', 'barbecue', 'yawn', etc.). The learners' mean production accuracy is summarized in Table 7.3.

Target	Tests		
	Pre-test	**Post-test**	**Delayed post-test**
Grammar	71.50 (26.89)	88.63 (21.34)	80.11 (25.51)
Lexical	27.94 (17.25)	85.00 (18.32)	68.87 (31.08)
Mixed	42.59 (21.03)	86.87 (21.77)	66.25 (29.10)

Table 7.3 Mean accuracy (per cent correct) for picture description as a function of target (standard deviations appear in parentheses)

The preceding analyses indicated that the learners in this study were overall able to detect the corrective nature of feedback received and to benefit from such feedback targeting both lexical and morphosyntactic errors in their speech. However, the noticing and production data analyzed thus far were characterized by a large amount of individual variability (see *SD* values in Tables 7.2 and 7.3). Indeed, the individual learners' production accuracy (regardless of the target type) ranged from a minimum of 0 to a maximum of 100 per cent correct. Although the variation in noticing was smaller by far, these scores nevertheless spanned a 27–59 per cent range, from a low of 41 to a high of 100 per cent accurate detection of mismatched (erroneous) targets following recasts. The next analyses were therefore conducted to explain individual variability in the learners' ability to notice and benefit from recasts, using measures of phonological memory, working memory, attention control, and analytical ability as predictors.

Cognitive factors and the noticeability and effects of recasts

To explore the relationship between the learners' ability to notice and benefit from recasts and their individual differences in attention, memory, and language aptitude, zero-order correlations were computed between the learners' noticing and production scores, on the one hand, and their phonological memory, working memory, attention control, and analytical ability measures, on the other. Because a large number of correlations were computed, the alpha level for significance was adjusted using the Bonferroni correction. Summaries of these analyses for noticing and production appear in Table 7.4 and Table 7.5, respectively.

Target	Predictor variables			
	Phonological memory	**Working memory**	**Attention control**	**Analytical ability**
Grammar	-.03	.19	-.13	.22
Lexical	-.10	.16	-.32	.38
Mixed	-.34	-.06	-.30	.44

Table 7.4 Summary of correlation analyses between predictor variables and noticing scores as a function of target

The first set of correlation analyses explored the relationship between the learners' noticing scores and the four predictor factors (Bonferroni corrected $\alpha = .004$). As seen in Table 7.4, there were no significant associations between the learners' noticing scores and any of the four factors examined. This finding likely reflects the relative salience of the interactional feedback received (focused on all types of targets) in the context of the picture description task. This salience may have minimized the need for the learners to rely, in their processing of recasts, on attention, memory, and language aptitude in order to notice the targeted error. Another possibility is that the task used here to measure noticing did not draw heavily on the learners' processing resources; thus, it did not allow us to detect the influence of the examined cognitive (processing) factors on the learners' ability to notice recasts.

The next set of correlation analyses explored the relationship between the learners' production accuracy and the four predictor factors (Bonferroni corrected $\alpha = .0013$). These analyses revealed several findings. (See Table 7.5.) First, there was a relatively strong and significant negative association between the learners' attention control and their accuracy at producing targets on the pre-test (for grammar targets), on the post-test (for mixed targets), and on the delayed post-test (for all targets). That is, higher production accuracy was related to more flexible executive attention control, conceptualized as a lower cost (hence, negative correlation) incurred due to the alternation between digits and letters in Part B of the attention control test. Second, there was a relatively strong and significant positive association between the learners' analytical ability and their accuracy at producing grammar targets on the delayed post-test. That is, higher production accuracy on grammar targets was related to better analytical skills, conceptualized as the ability to focus on structural properties of language. Third, the associations between the learners' phonological and working memory and their production accuracy were weak and non-significant. Finally, significant associations were obtained (in large part) for production accuracy on the delayed post-test rather than on the post-test. This last finding is indicative of a greater demand on processing resources in situations when interactional feedback or other sources of positive and negative evidence are not available for immediate processing. Also, it is noteworthy that the four predictor factors were not correlated with one another (*p*s > .06), suggesting that the four cognitive dimensions measured in this study represented separable constructs. In addition, the four predictor factors were not correlated with any of the proficiency scores (ps > .31) obtained in a separate task (lexicosemantic and morphosyntactic accuracy scores, speech rate). This finding indicated that the four cognitive (processing) factors were associated only with the learners' accuracy rates in the picture description task and were not predictive of their overall L2 proficiency at the time of testing.

Target	**Predictor variables**			
	Phonological memory	**Working memory**	**Attention control**	**Analytical ability**
Pre-test				
Grammar	.30	.27	-.55**	.44
Lexical	.25	.12	-.17	.07
Mixed	.41	.26	-.44	.35
Post-test				
Grammar	.36	.34	-.51	.47
Lexical	.23	.38	-.37	.21
Mixed	.26	.48	-.66***	.45
Delayed post-test				
Grammar	.41	.28	-.60***	.55**
Lexical	.11	.22	-.55**	.20
Mixed	.24	.27	-.56**	.52

Asterisks identify correlation coefficients that remained significant after a Bonferroni correction ($\alpha = .0013$). ** $p < .001$ *** $p < .0001$, two-tailed

Table 7.5 Summary of correlation analyses between predictor variables and picture description scores as a function of target and test

The final set of analyses, using step-wise multiple regression, was conducted to estimate the unique contributions of phonological memory, working memory, analytical ability, and attention control to predicting the learners' accuracy at producing grammar, lexical, and mixed targets on both the post-test and the delayed post-test. No such analyses were carried out to predict the learners' ability to notice the linguistic targets following recasts because there were no strong associations between noticing scores and the four predictor factors. (See Table 7.4.) In each analysis, the accuracy score (for each linguistic target and test) was used as the criterion measure, and the phonological memory, working memory, analytical ability, and attention control scores were entered separately as predictors, in decreasing order of their correlation with the criterion variable (entry criterion: $p \leq .05$). In each analysis, either the learners' morphosyntactic, or lexicosemantic accuracy scores, or both (based on the speaking test described earlier) were entered first, as a measure of L2 proficiency, in Step 1 of the analysis. Thus, the morphosyntactic accuracy score was entered in Step 1 of the analyses for the grammar targets. The lexicosemantic accuracy score was entered in Step 1 of the analyses for the lexical targets. Both the morphosyntactic and lexicosemantic scores were entered in Step 1 of the analyses for the mixed targets. Next, the four predictors were entered all together, in Step 2 of each analysis. This two-step procedure allowed for estimating the contribution of phonological memory, working memory, attention control, and analytical ability that was *independent* from the learners' individual differences in L2 proficiency.

The regression analyses using production accuracy on the post-test revealed that proficiency (measured by either the morphosyntactic, the lexicosemantic score, or both) explained 21–57 per cent of the unique variance (R^2) in production accuracy, Fs $(1, 30) > 8.04$, ps $< .01$. This contribution of proficiency was significant, ß range = - .46 – -.70, ps $< .01$. Attention control accounted for an additional 14–23 per cent of the unique variance in production accuracy for the grammar and mixed, Fs $(2, 29) > 7.96$, ps $< .0025$, but not lexical, targets. The contribution of attention control was also significant, ß range = - .40 – -.51, ps $< .025$. The proportion of the unique variance (R^2) explained by each predictor on the post-test is depicted in Figure 7.3. These results suggest that only attention control explained a significant amount of the learners' accuracy at producing linguistic targets, an amount that was over and above that attributable to L2 proficiency alone.

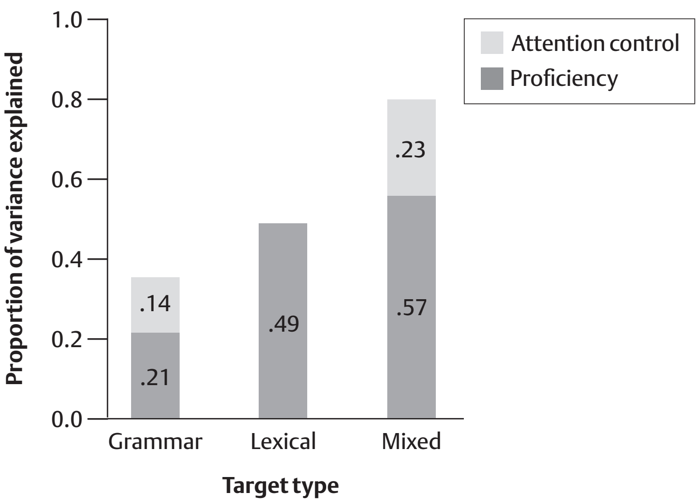

Figure 7.3 The proportion of the unique variance (R^2) explained by each of the predictor variables on the post-test as a function of linguistic target

The regression analyses using production accuracy on the delayed post-test revealed that proficiency (measured by either the morphosyntactic, the lexicosemantic score, or both) explained 19–45 per cent of the unique variance in production accuracy, Fs $(1, 30) > 7.17$, $ps < .025$. This contribution of proficiency was significant, ß range = - .444– -.61, ps $< .025$. Attention control accounted for an additional significant 17–23 per cent of the unique variance in production accuracy for the grammar, lexical, and mixed targets, *F*s (2, 29) > 10.02, *ps* < .001, ß range = - .44 – -.51, *p*s < .0025. Moreover, analytical ability explained an additional significant 9 per cent, *F* (3, 28) = 10.20, *p* < .001, ß = .29, *p* < .05, while phonological memory an additional significant 8 per cent of the unique variance, *F* (4, 27) = 10.57, *p* < .001, ß = .35, *p* < .025, in production accuracy for the grammar targets only. The proportion of the unique variance (R^2) explained by each predictor on the delayed post-test is depicted in Figure 7.4. These results suggest that attention control, analytical ability, and phonological memory explained a significant amount of the learners' accuracy, mainly at producing grammar targets. Again, the contributions of these cognitive factors were independent of L2 proficiency.

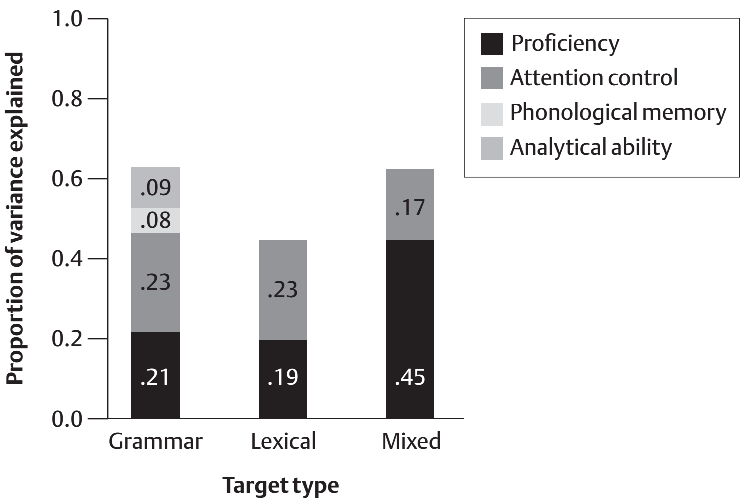

Figure 7.4 The proportion of the unique variance (R^2) explained by each of the predictor variables on the delayed post-test as a function of linguistic target

Discussion

Summary of findings

The goal of the study reported in this chapter was to investigate the noticeability and effectiveness of recasts as a function of learners' individual differences in phonological memory, working memory, analytical ability, and attention control. First, analyses of the learners' noticing scores (defined as the ability to detect the targeted error following a recast) revealed that, when the learners made errors and then received a recast, they were more likely to detect their lexical than their morphosyntactic errors. Second, analyses of the learners' accuracy in producing linguistic targets revealed that overall the learners benefited from the recasts received. Their production accuracy on the post-test and delayed post-test was superior to their accuracy on the pre-test. These two findings are in line with the results of previous studies that cited lower noticing rates for recasts targeting morphosyntactic than lexical errors (Mackey *et al.* 2000) and showed beneficial effects of recasts on learner accuracy (Mackey and Philp 1998; Ammar and Spada 2006; and the studies summarized in the introduction to this volume).

Further analyses, conducted to identify factors that influence learners' ability to notice and benefit from recasts, revealed several significant predictors of the learners' production accuracy, but not their noticing. In particular, the learners' morphosyntactic and lexicosemantic accuracy scores (proficiency measures established in a separate task) accounted for 19–57 per cent of the unique variance in the learners' accuracy of producing linguistic targets. That is, the higher proficiency learners in this study overall benefited from recasts more than the lower proficiency learners, suggesting that learners' existing knowledge of a particular form or the state of their 'readiness' to acquire it (or perhaps both) enhance the usefulness of recasts for them. In addition, measures of attention control, analytical ability, and phonological memory accounted for significant proportions of the unique variance in the learners' production accuracy. For example, the combined contribution of these three factors explained 40 per cent of the unique variance in the learners' ability to accurately produce grammar targets (English PDs) on the delayed post-test. This contribution was independent of L2 proficiency. That is, large phonological memory, efficient attention control, and strong analytical ability appear to be associated with learners' accurate production of L2 morphosyntax after hearing a recast. Each of these factors appears to have an independent effect on learners' ability to benefit from recasts. The *combined* influence of these factors on the usefulness of recasts is, however, unclear as the relationship *among* these complex cognitive constructs is not well understood. Nevertheless, these findings are consistent with the results of previous studies that cite greater benefits of recasts for higher than lower proficiency learners (Mackey and Philp 1998) and link working and phonological memory with the effectiveness of recasting (Mackey *et al.* 2002). Moreover, these findings go beyond previously reported results in suggesting that attention control and analytical ability are also central to the usefulness of recasts.

Cognitive factors and recasts

Before discussing the effect of cognitive factors on the effectiveness of recasts, it is important to address one finding of this study that seemingly contradicts previously reported data. In the only study that has, to date, examined the contributions of working and phonological memory to the noticeability of recasts, Mackey *et al.* (2002) reported that learners with larger working and phonological memory spans tended to be more likely to notice the error targeted by recasts than learners with smaller spans. By contrast, in this study, measures of working and phonological memory (or any other measure, for that matter) were not associated with noticing rates. Reasons for this discrepancy may be the different methodologies employed by the two studies to measure noticing (stimulated recall versus visually cued discrimination) or to the different measures of phonological and working memory used (non-word recall, listening span versus serial non-word recognition, letter–number sequencing). Perhaps a more plausible reason for this discrepancy lies in the relative salience and predictability of the corrective feedback in the two studies. In this study, recasts were frequent. Of the 120 picture descriptions, 48 were followed by a native speaker response, whether or not an error occurred. The feedback received in the context of a computerized task was therefore contextually prominent, perhaps more so than it would be in an interaction with a partner in a more naturalistic situation, for example, as used by Mackey *et al.* (asking questions about a picture). This salience and predictability of interactional feedback may have consequently made the task used to measure noticing less demanding, thereby minimizing the role of individual differences in learners' attention, memory, and language aptitude.

Although none of the cognitive factors examined here predicted the rate at which the learners noticed mismatched (erroneous) linguistic targets following recasts, the effect of individual differences on the learners' use of the information available in recasts was clear. Measures of attention control, phonological memory, and analytical ability explained up to 40 per cent of variance in L2 morphosyntactic accuracy (use of English PDs) and up to 23 per cent of variance in L2 lexical accuracy (use of English verbs), in excess of what was explained by L2 proficiency alone. Taken together, these findings show how cognitive constructs of attention, memory, and language aptitude 'shape' L2 interaction on a minute-by-minute basis in a simple task.

One cognitive factor that appears to determine the effectiveness of recasting is phonological memory. The finding of this study that phonological memory explained a modest (yet significant) proportion of variance in L2 morphosyntactic accuracy on the delayed post-test suggests that phonological memory is likely involved in L2 interaction at the level of L2 morphosyntax rather than at the level of L2 lexicon (c.f., Service 1992; N. Ellis and Sinclair 1996; O'Brien *et al.* 2006). Phonological memory might underlie learners' ability to encode and subsequently use, in the course of interaction, elements of L2 morphosyntax targeted by recasts. Because the effect of phonological memory on learners' production was detectable only on the delayed post-test, it is possible that phonological memory may play an essential role in shaping long-term benefits of interactional feedback. That is, individual differences in learners' phonological memory spans may be particularly predictive of learners' ability to benefit from recasts precisely at the time when the exact auditory percept of the spoken recast is no longer available. At this point, learners may need to rely on their phonological memory to maintain the form of the recast in their short-term memory to be able to analyze it for further processing. This role of phonological memory in interaction is likely akin to that proposed to mediate self-perception, or the ability to detect phonological errors in one's own speech (Baker and Trofimovich 2006). That is, phonological memory may ensure that learners maintain, in an active state, their own spoken utterances or those produced by others, thereby making these utterances available for subsequent storage or processing.

Another cognitive factor that likely determines the effectiveness of recasts is analytical ability. The finding of this study that analytical ability accounted for a modest (yet significant) proportion of variance in L2 morphosyntactic accuracy on the delayed post-test suggests that analytical ability may mediate the benefits of recasts for learners' use of L2 morphosyntax. Analytical ability likely determines learners' capacity to identify and focus on the structural properties of their own speech and the speech addressed to them. Thus, learners with stronger analytical skills may be more likely to engage in a 'deeper' processing of a recast and therefore undertake a more efficient analysis of its formal properties than learners with weaker analytical skills. Because the effect of analytical ability was detected in this study only on the delayed post-test, analytical ability may play a greater role in L2 interaction at the time when interactional feedback or other sources of negative (or positive) evidence are no longer available. In fact, this 'delayed' effect of analytical ability and phonological memory on the 'deployment' of L2 morphosyntax (Long 2006) is consistent with recent claims that learners' performance immediately following interactional feedback is not necessarily predictive of longer-term learning and that interactional feedback-driven learning is often delayed (Mackey and Philp 1998; Mackey 1999). As the results of this study suggested, after a mere 2–12 minutes following the presentation of a recast, learners are no longer as accurate at producing L2 morphosyntactic and lexical targets as they are at doing so immediately after a recast. (See Table 7.3.) More importantly, their performance after a short delay appears to be highly contingent on the available processing resources and conditional on learners' individual differences.

Last but not least, attention control or the ability to efficiently allocate attention among different aspects of language or different cognitive processing tasks appears to determine the effectiveness of recasts as well. The finding of this study that attention control predicted a large and significant amount of L2 morphosyntactic and lexical accuracy in learners' production is indicative of the contribution of attention control to L2 interaction and is consistent with previously documented effects of attention control on L2 proficiency (Segalowitz and Frenkiel-Fishman 2005). In a recent study, Taube-Schiff and Segalowitz (2005) clarified the nature of the link between L2 proficiency and attention control. They showed that, in fact, L2 proficiency is related to the ability to efficiently allocate attention among relational (grammaticized) aspects of the L2 (for example, spatial prepositions), but not among its non-relational (lexical) aspects (for example, nouns). In other words, high L2 proficiency appears to be associated with efficiency in shifting attention among grammaticized (morphosyntactic) elements of the L2. Whether or not L2 proficiency is related to efficient attention shifting among morphosyntactic or lexical aspects of the L2 (or both), the findings reported here suggest that accurate L2 use may be contingent on efficient attention control. In L2 interaction, attention control may characterize learners' ability to efficiently switch attention among different aspects of language or among different cognitive tasks, thereby determining learners' success in using interactional feedback.

Limitations and conclusions

The present study has several limitations that concern the nature of interactional feedback provided to the learners as part of a computerized task. As discussed earlier in this chapter, the online picture description task employed here required that native speaker responses be provided to the learners in response to all critical utterances, both targetlike and erroneous. To overcome this limitation, for our analyses of the noticeability of recasts we used only the data that were based on 'true' recasts, operationalized here as pre-recorded native speaker responses reformulating the learners' erroneous picture descriptions. It is likely, however, that the resulting noticing rates may have been 'inflated' by the additional positive evidence available to the learners through non-corrective repetitions following their targetlike picture descriptions. If indeed present, this additional contribution to noticing was, however, small, as the linguistic targets used in this study were seemingly already salient in a laboratory-based task containing a number of repeated items. Presumably, the presence of non-corrective repetitions may have also exaggerated the learners' production accuracy rates, thus potentially inflating the extent to which recasting was shown to be effective. Again, the likelihood of this was, however, small. First, it is unlikely that a few non-corrective repetitions would significantly affect already stable, targetlike performance. Second, the learners' existing knowledge of the linguistic targets was partialled out, as part of their L2 proficiency scores, in the regression analyses carried out to examine the production data. These reasons notwithstanding, the limitations outlined above warrant further investigation into the noticeability and effectiveness of recasts under circumstances that allow researchers to determine exactly *what* learners notice as they hear recasts and thus to isolate their corrective nature.

Situated within L2 interaction research, this study was conducted to explain learners' difficulties in L2 learning at the level of individual differences. More specifically, this study examined the role of four cognitive factors in determining learners' ability to notice and benefit from recasts, an interactional feedback technique that aims at promoting L2 development in the context of meaningful interaction. Results overall showed support for the involvement of three (phonological memory, attention control, analytical ability) of the four factors in determining the effectiveness of recasts, lending further evidence to previous claims that implicate attention, memory, and language aptitude factors in L2 development (Skehan 2002).

At a general level, the findings of this study contribute to an understanding of individual differences from a perspective that casts L2 learning as the development of flexible and fluent cognitive processing skills in an unpredictable, often changeable interactive environment. (See Segalowitz 1997 for more details on this view of individual differences.) Although the picture description task used here imposes far fewer (and perhaps different) demands on L2 learners than face-to-face interaction, in which interlocutors may go 'off topic' and may focus on a particular discourse or language feature unexpectedly, the cognitive skills involved in this task are likely representative of such an interaction. This study, however, is only a preliminary attempt to untangle the many factors determining the effectiveness of interactional feedback. It leaves unanswered many questions about, for example, the role of other, non-phonological, aspects of working memory in determining the noticeability and effectiveness of recasts (see Miyake and Friedman 1998) or about the role of individual difference factors in naturalistic face-to-face interaction. These and other questions remain to be explored in future research.