Multiple Aptitudes for Instructed Second Language Acquisition

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Robinson, Peter. 2003. **Multiple Aptitude for Instructed Second Language Acquisition.** *Korean Journal of English Language and Linguistics* 3-3, 375-410. As Snow (1989) and Sternberg (1985) have long argued, learning, and adaptation to the learning environment or classroom context (at the levels of instructional treatment, interventionist focus on form technique, or pedagogic task) is a result of the *interaction* of *context* at each of these levels of description with learners' *patterns* of abilities. In this paper I argue that this is an important area of research for SLA pedagogy, as well as SLA theory development, and I review recent developments in the study of L2 learning conditions; of the abilities contributing to L2 aptitude; and of their interaction with the processes involved in successful classroom learning and practice, and propose a model of 'multiple aptitudes' for classroom learning based on these findings.

Key Words: instructional contexts, individual differences, learning

1. Context, Level 1: Laboratory Research, Attention, and Awareness

In recent years a considerable amount of experimental laboratory, and classroom research has investigated the effects of L2 learning under different conditions of exposure. One aim of the experimental laboratory research has been to identify relationships between the information processing demands of different 'instructional sets' to the L2 learning targets (for example +/- awareness of the targets, +/- intention to learn the targets, and +/- implicit or explicit metalinguistic information about the 'form' of the targets), and the extent (short term and long term) of the influence of these instructional sets on learning (see DeKeyser, 1995, 1997; De Graaff, 1997; N.Ellis, 1993; Hulstijn, 1989; Robinson, 1996a, 1997b, 2002b; Robinson & Ha, 1993; Williams, 1999; Williams & Lovatt, 2003). Contrary to theoretical claims, such as those of Krashen (1982) and Reber (1989) that implicit (unaware, and unintentional) learning is more effective than explicit learning, especially where the stimulus domain is complex, DeKeyser (1995) Robinson (1996a) and DeGraaff (1997), all found that L2 learning in explicit conditions, involving some degree of metalinguistic awareness and instruction, were at least as effective as learning in implicit conditions where the stimulus domain was complex, and was, on the whole, much more effective where the L2 stimulus domain was simple.

In fact, there is evidence that learning in the implicit conditions of these studies, as in the explicit conditions, is a conscious process, and does not result from qualitatively different nonconscious 'implicit learning' mechanisms. De Graaff (1997), Robinson (1997a) and Williams (1999) all found individual differences in aptitude (as measured by subtests of conventional aptitude batteries, such as MLAT) and memory ability influenced learning across implicit *and* explicit conditions, suggesting that adult L2 learning under all conditions of exposure is Fundamentally Similar (Robinson, 1996b, 1997a, 2002b) since differences in the extent of learning in these conditions was affected by individual differences in the conscious information processing abilities measured by the aptitude and memory tests. Where strengths in patterns of abilities, or aptitudes, matched the processing demands of specific task conditions, that research has suggested, such patterns of abilities facilitated L2 learning. These findings are of potential importance, as I will describe later in this paper, for proposals about matching learners to instructional conditions and options which provide optimum opportunities for L2 learning and practice.

These findings, of course, stand in opposition to Krashen (1981, 1985) and Reber's (1989, 1993) claims that implicit learning, or 'acquisition' is fundamentally different from explicit 'learning' since (Krashen and Reber claim) the former—in contrast to the latter—draws on unconscious processes, outside of executive control, and is insensitive to differences between learners in the abilities contributing to successful attentional allocation and efficient memory rehearsal. With the utility (or not) of consciousness in the sense of 'awareness' in mind, Robinson (1996a, 1997a) studied the effects of four conditions of exposure (*implicit*, memorize examples only; *incidental*, process examples for meaning; *rule-search*, try to find rules; *instructed*, apply a rule explanation to examples) on the acquisition of simple, versus complex L2 structures. Implicit learners in the study, in general, learned poorly. However, for implicit learners in particular, there was a strong link between the abilities measured by a conventional measure of L2 learning *aptitude* (the grammatical sensitivity subtest of the MLAT), posttest L2 learning *success* and—following experimental exposure and immediate posttest performance—*awareness* (at the levels of self reported looking for regularities in the input, and ability to verbalize partial rules about the structure of the input). Learners in the implicit L2 learning condition, with high L2 aptitude were found to be those most likely to attest to having looked for structural regularities in the L2 input during implicit exposure, and also to be able to verbalize rules about them following exposure.

Table 1
Planned comparisons of aptitude subtest scores for aware and unaware learners in the implicit condition of Robinson (1997a)

	Level of awareness		
Aptitude subtest	Noticed	Looked for rules	Verbalized rules
MLAT Grammatical sensitivity	ns.	p = .016	p = .002
MLAT Rote memory	ns.	ns.	ns.

Table 2
Planned comparisons of the accuracy of aware and unaware learners in the implicit condition of Robinson (1997a) on the posttest of easy and complex rule knowledge

Rule	Level of awareness		
	Noticed	Looked for rules	Verbalized rules
Easy	ns.	p = .03	p = .01
Hard	ns.	p = .02	p = .005

Table 1 shows the results of planned comparisons of aptitude scores for those who claimed to have *looked for rules*, versus those who didn't, and those who could *verbalize rules*, and those who couldn't. In each case the grammatical sensitivity aptitude scores of the aware implicit learners were significantly higher than the unaware learners. One can infer, then, that this aptitude subtest positively affects the potential to become aware during implicit L2 exposure. And awareness led to more learning for those implicit learners, as Table 2 shows. There it can be seen that learners who looked for rules, or could verbalize them, were significantly different from (and more successful than) their unaware counterparts in measures of learning both the simple and complex rules. Thus it appears that aptitude led to awareness for implicit learners, which positively affected learning. The full pattern of correlations between the scores on the aptitude subtests and learning in each of the four conditions studied is shown in Table 3.

Table 3, then, shows aptitude to affect learning in all conditions, except the incidental processing input for meaning condition. Krashen (1985) would take this as some support for his claim that acquisition occurring during processing for meaning (not form) is insensitive to individual differences in aptitude. However, I reasoned that the two aptitude subtests used (rote memory for pairs of words, and grammatical sensitivity) were less likely to have matched the specific processing demands of this condition, than the other conditions (memorize examples, search for rules, or apply previously learned metalinguistic explanations to examples). In a subsequent study of incidental L2 learning (see Robinson, 2002b), these measures of aptitude were similarly found to be poor predictors of incidental learning, but a measure of 'working memory for text' based on Daneman and Carpenter's (1980) reading span test of working memory, was a strong positive predictor of successful incidental learning. This is understandable, I argued, since processing input for meaning during incidental learning creates no opportunities for rote memorization of examples encountered, or for the intentional application of explicit metalinguistic knowledge to input, but does draw on the ability to process for meaning while *simultaneously* switching attention to form during problems in semantic processing—an ability which is strongly related to working memory capacity. The positive correlations of incidental learning and working memory for text in that study were robust, being significant on immediate, one week, and six month delayed posttests of incidental learning, using a number of measures of learning.

Table 3
Correlations of scores on aptitude subtests and learning easy and hard rules in all conditions of Robinson (1997a)

	Aptitude (MLAT)		
Condition/Rule	Grammatical sensitivity	Rote memory	Total aptitude
Implicit			
easy	.69*	.3	.52*
hard	.75*	.25	.52*
Incidental			
easy	.35	.31	.39
hard	.28	.14	.23
Rule-search			
easy	.6*	.42	.56*
hard	.37	.51*	.5*
Instructed			
easy	.54*	.49*	.63*
hard	.56*	.46*	.62*

* = $p < .05$

1.1. Comments on the Laboratory Research Findings

One conclusion to be drawn from these studies of different learning conditions, and their relationship to aptitude, is that while conventional measures of aptitude are suitable for predicting successful learning during some conditions of exposure and practice they also need to be supplemented by other measures, especially where the form of exposure involves processing for meaning alone, with no intentional focus on form—an issue I return to later in this paper.

The research summarized above, then, has begun to uncover ubiquitous relationships between individual differences in aptitude (even using only subtests of conventional aptitude batteries, such as MLAT), along with the influence of differences in memory abilities, with *awareness*, and subsequent L2 *learning*$_L$ under a wide variety of closely controlled experimental learning conditions. Such learning conditions are specified, delivered and observed at a sufficient level of contextual and temporal granularity that one can, I think, make valid inferential claims about their relationship to individual differences, and also to the causal interactions of both with putative SLA processes (such as awareness, as it results from noticing, and intentional rule-search) and subsequent L2 learning success, which therefore are of explanatory value for both SLA theory and for the pedagogic issue of matching learners to optimum conditions of L2 exposure and practice.

2. Context, Level 2: Attention, Awareness and Focus on Form

Closely related, and complementary, to this laboratory research has been classroom research which examines the effects of different kinds of intervention which aim to direct learner attention to L2 form during classroom activities (see Doughty & Varela, 1998; Doughty & Williams, 1998; Leow, 1997; Long & Robinson, 1998; Muranoi, 2000;

Robinson, 2002d; Van Patten & Oikennon, 1996). Again, the issue of interest has been the influence of attention to, and awareness of the form of L2 input during communicative activity on subsequent learning, where the learning outcome of interest in this research has been both memory for, long term retention of, and automatic access to, the L2 input encountered during instructional exposure, as well as generalizability of the L2 knowledge base established during exposure to new contexts and novel L2 material (see e.g., Robinson, 1997b). The degree of attention to, and awareness of, form during processing of L2 information has been manipulated via use of various focus on form techniques such as input flooding (a minimally intrusive technique for directing attention to form during input processing, see e.g., White, 1998), input enhancement (see Leeman, Arteagoita, Fridman, & Doughty, 1995), recasting (Doughty & Varela, 1998), and input processing and rule explanation (Van Patten & Cadierno, 1993)—the latter studies increasingly adopting more communicatively intrusive, and attentionally demanding (and so message-content distracting) focus on form techniques.

Findings for this research have produced mixed results to date, with some studies showing input enhancement and recasting to have an effect, but not others, while input processing/rule explanation has been claimed to have almost unqualified success in the limited domains of L2 structure it has been applied to (see Van Patten, 2002, for a review, and DeKeyser, Salaberry, Robinson and Harrington, 2002, for a critique of the argued replicability of findings). So far, however, focus on form research in general has failed to substantially examine the interaction of L2 learning via such techniques with individual differences in patterns of abilities, and this could be an important explanation for the lack of overall significant gain by groups in some studies—especially those adopting less intrusive, and also less metalinguisticability-dependent, techniques for focus on form such as input flooding and recasting. The abilities necessary for learning from these two latter techniques, that is, may not be as homogeneously high in the usual studied population of learners (university level students, who have considerable schooled, analytic, and so metalinguistic abilities) than the abilities necessary to learning from input processing instruction (which are largely metalinguistic, I will argue below, and which university level language majors can be expected to have, simply by virtue of their schooling and prior exposure to formal instruction). Therefore there may be more variation in L2 learning, because of less ability matching with the SLA processes contributing to learning from input flooding or recasting, and so smaller group effects for learning from these focus on form techniques, than for techniques such as input processing instruction which draw on a common group-wide (because schooled) set of metalinguistic abilities.

Nonetheless, the larger issue is that in any studied population of L2 learners some learners' aptitudes or sets of abilities may be more suited to learning from one focus on form technique versus another. Two studies to date indicate this may be so with regard to recasting. Robinson and Yamaguchi (Robinson, 1999; Robinson & Yamaguchi, 1999)—using university level, non language majors, who had met minimal language learning university entrance exam requirements—found high significant positive correlations (see Table 4) of measures of phonological sensitivity and also rote memory (using Sasaki's Language Aptitude Battery for the Japanese), with learning from recasts during task-based interaction over a five-week period. Learning was measured by pre and posttest gain scores on an elicited imitation measure of relative clause production (the form targeted in the study). Similarly, Mackey, Philp, Egi, Fujii, and Tatsumi (2002) (using students at a range of levels, in a foreign language EFL program) also found significant positive relationships between measures of phonological working memory capacity, noticing of information targeted by recasts (features of *wh*-question formation) delivered over three weeks during communicative L2 interaction, and subsequent interlanguage development; with the caveat that learners at higher developmental levels showed this relationship more clearly than learners at lower developmental levels.

Table 4
Correlations of aptitude with elicited imitation measures of relative clause learning from recasts in Robinson and Yamaguchi (1999)

Aptitude (LABJ)	Gain Scores on Elicited imitation
Grammatical sensitivity	-.09
Rote memory	.51*
Phonetic sensitivity	.5*
Total aptitude	.44

* = p < .05

2.1. Comments on the Focus on Form Findings

Taken together, the findings for a positive relationship between phonological sensitivity, and memory ability and learning from recasts in Robinson and Yamaguchi's (1999) study, and phonological working memory, noticing of recast information, and subsequent L2 development in Mackey et al. (2002) suggests that these very similar abilities *are* positively implicated in aptitude for learning from the recasting focus on form technique. However, as with the finding for incidental learning in the Robinson's (1997a) study reported above (see Table 3), in Robinson and Yamaguchi (1999) there were low, non significant correlations of learning of relative clauses during task-based meaning focussed interaction (supplemented by targeted recasts) and the grammatical sensitivity aptitude subtest (see Table 4). Therefore the findings of Robinson (1997a) and Robinson and Yamaguchi (1999) also constitute evidence for a possible inference across contexts (laboratory studies of incidental learning, and classroom studies of focus on form during task-based learning) about the *non* influence of individual differences in *grammatical sensitivity* on aptitude for incidental learning during processing for meaning.

As with the laboratory research described above, then, these findings suggest that learners may differ in their aptitude(s) for learning from one technique for focus on form versus another—an issue I address again in the section below on contemporary approaches to aptitude and the issue of matching L2 learners to conditions of exposure and practice.

3. Context, Level 3: Task Based Learning, and Task Design

The same rationale for studying the role, and degree of, attention to, and awareness of form during laboratory and classroom focus on form studies has also guided research into the effects of the cognitive demands of L2 tasks on learning, both in experimental and classroom contexts. In this research design features of tasks which are hypothesized to impose differential information processing demands (e.g., single versus dual task; +/- reasoning, +/- planning time for the task, or +/- prior knowledge of the task domain) have been studied for their effects on L2 performance (i.e., accuracy, fluency, and complexity of production, and amount of interaction) (see e.g., Bygate, 2001; Crookes, 1989; Foster & Skehan, 1996; Ortega, 1999; Rahimpour, 1999; Robinson, 1995a, 1996c, 2001a; Robinson, Ting& Urwin, 1995; Skehan & Foster, 1997, 1999). I have argued, in line with what I have called the Cognition Hypothesis of task-based learning, (see Robinson, 2001b, 2002e, 2002g), that where L2 tasks are low in their cognitive demands this will facilitate fluency and automatisation of access to an existing L2 repertoire. However where tasks increase in complexity along resource-directing dimensions (such as those requiring reasoning, or reference to the there-and-then) learners will attempt to break the confines of their current L2 repertoire and produce more complex and accurate language in response to the cognitive and functional demands of the task. This can be thought of as both a process of syntacticizing, and increasing the propositional and morphological complexity of speech to match the increasing conceptual and communicative demands (cf. Cromer, 1991; Givon, 1985, 1995; Robinson, 1995a; Rohdenburg, 1996; Slobin, 1993), and also as a process of analysing, or 'fissioning' currently available chunks, or procedural 'frames' for event structures that enable fluent language use (Ellis, 2001; Fillmore, 1985; Goldberg, 1995; Myles, Mitchell & Hooper, 1998; Peters, 1984; Robinson, 1986, 1989, 1990, 1992; Talmy, 2000, 2003). I have also argued that increasing the cognitive demands of tasks will not only change the nature of task production, but will also lead to more L2 learning (uptake of, and memory for new input), and longer term retention of input. It follows from these claims (summarized in Figure 1) that practice on a series of simple tasks is likely to have different L2 performance and learning effects than practice on a series of progressively more complex tasks, with important potential consequences for task-based pedagogy.

Figure 1
Task complexity, learning, and monologic/interactive task performance along resource-directing dimensions

Tasks, noticing, incorporation of input, and input retention	
simple	**complex**
- noticing	+ noticing
- incorporation of input	+ incorporation of input
- retention of input	+ retention of input
shallow semantic processing	deep semantic processing
Monologic task production	
simple	**complex**
+ fluency, - complexity, - accuracy	- fluency, + accuracy, +complexity
Interactive task production	
simple	**complex**
+ fluency, - accuracy,	- fluency, + accuracy,
- comprehension checks	+ comprehension checks
- clarification requests	+ clarification requests

An increment of this work on the laboratory studies (and to a potentially somewhat lesser extent, the focus on form studies) referred to above, is that studying the effects of *cognitive* design features of classroom learning tasks (which affect the extent of attentional, reasoning, and memory demands the task make on the learner) can also be done while varying implementational details of task *participation* (such as whether the task requires simple information transmission or two-way information exchange), and task *participants* (such as the familiarity/unfamiliarity, or same/different gender of the task participants) and looking for effects of interactions (or not) of these different kinds of factor on L2 learning and performance outcomes. Cognitive (task) factors, and participation (context) factors are illustrated in Figure 2, together with another group of individual difference (learner) factors, such as L2 learning aptitude, and anxiety (and I return to the potential interaction between these sets of factors during task-based language practice in detail later in this paper).

Figure 2
A componential framework for mapping task, context and learner interactions (adapted from Robinson, 2001b)

Task complexity (cognitive factors)	Task conditions (interactional factors)	Task difficulty (learner factors)
a) resource-directing dimensions e.g. +/- few elements +/- here-and-now +/- no reasoning demands	a) participation variables e.g. open/closed one-way/two-way convergent/divergent	a) affective variables e.g. motivation anxiety confidence
b) resource-depleting dimensions e.g. +/- planning +/- single task +/- prior knowledge	b) participant variables e.g. gender familiarity power/solidarity	b) ability variables e.g. aptitude working memory intelligence
TASK DESIGN	PERFORMATIVE CONTEXT	LEARNER PERCEPTIONS
	INTERACTIONS	

This research has begun to show that some features of L2 task design, such as the complexity of cognitive demands, do have effects on L2 performance, sometimes leading to greater accuracy (Iwashita, Elder & MacNamara, 2001; Rahimpour, 1997; Robinson, 1995a), as well as more extensive uptake and learning of new L2 knowledge, e.g., incorporation of input, with significantly more of this taking place on complex tasks (Robinson, 2002e), which also generate most interaction (Robinson, 2001a). In contrast simpler tasks have been shown, on the whole, to promote fluency and consolidation of previously learned language (see Robinson, 1995a, 2001a). Task repetition (Bygate, 2001), and the provision of planning time (Crookes, 1989; Foster & Skehan, 1996; Skehan & Foster, 1997) have also been shown, in a number of cases, to systematically affect the fluency of L2 production, with potentially important consequences for automatising access to known material.

This said, the findings summarized above have not been exceptionless. However, as with the focus on form research, task research has as yet not substantially addressed the role of individual differences, and aptitudes, for learning and performance on specific tasks during task-based L2 learning. This is important for the same reason given above. Certain learners, with certain patterns of task related abilities, may be more suited to learning from, or production practice on, one task versus another (see Figure 2). That is, individual differences in abilities may also interact with L2 learning task characteristics to systematically affect speech production, uptake and learning, such that one type of learner may be systematically more fluent on one type of task than another, or systematically more accurate, or notice and use more new information provided in the task input, etc. These are important issues for the development of theoretically motivated and researched L2 task-aptitude interaction profiles which can be used to maximize on task practice, and learning, opportunities for L2 learners.

Related to this issue, one study (Niwa, 2000) has shown that as L2 tasks increase in complexity, so individual differences in abilities increasingly differentiate performance. This is consistent with the predictions of the Cognition Hypothesis of task-based L2 development described earlier which claims that increasing the cognitive demands of tasks will have L2 performance and learning effects (i.e., more uptake, noticing, greater accuracy and complexity, but less fluency on complex tasks relative to simpler versions), but that these effects will be more differentiated on more complex tasks than on simpler versions (see Figure 3). That is, as has been found in the study of complex task performance in other domains (see e.g., Fleishman & Quaintance, 1984, Ch.7; Knorr & Neubauer, 1996; and Tucker & Warr, 1996 for related findings), and as has been shown in studies of aptitude-treatment interactions (Snow, Kyllonen & Marshalek, 1984) individual differences in cognitive resources, and the abilities they contribute to, should increasingly differentiate performance and learning as tasks increase in complexity.

Figure 3
Interactions of individual differences (IDs) and measures of production and learning increase as tasks increase in cognitive complexity (adapted from Robinson, 2002e)

Simple tasks **few ID interactions**	**Complex tasks** **many ID interactions**

Production,

<-----------------accuracy, complexity, fluency, interaction----------->

Learning,

<----uptake, modification of output, syntacticization, stage shifts--->

Niwa (2000; Robinson & Niwa, in preparation) studied the effects of working memory, aptitude and intelligence on performing L2 narrative tasks at four different levels of complexity, which corresponded to increases in the reasoning demands the narratives imposed on speaker production (see Robinson, 2001b, 2002d for additional summary of these findings). Niwa's study, then, can be seen as an attempt to study the interaction of some of the learner factors contributing to perceptions of task difficulty illustrated in Figure 2 (such as working memory, and aptitude), with one dimension of tasks that contributes to their increasing complexity, i.e., the reasoning demands they impose. As can be seen in Table 5, the strongest pattern of significant correlations is for individual differences in intelligence (measured by a short form of the Wechsler Adult Intelligence Scale), L2 learning aptitude (measured using Sasaki's (1996) Language Aptitude Battery for the Japanese), and working memory (using a measure of reading span) on the accuracy, and particularly fluency of speaker's production on *the most complex* version of the narratives. This finding, then, suggests that individual differences in cognitive abilities lead to increasingly differentiated L2 speech production by learners on complex versions of tasks high in their reasoning demands, as Figure 3 illustrates. In a further study of the effects of increasing reasoning demands of L2 narrative tasks, Robinson (2002e) also found that as tasks increased in complexity, learners increasingly incorporated premodified L2 input available in the task materials into their own production. It remains to be seen whether findings for greater uptake and learning from modified input on complex relative to simple versions of tasks found in Robinson (2002e) may also be related to individual differences in the abilities contributing to aptitudes for task based learning and L2 practice. Again, this important question is only just beginning to be addressed.

Table 5
Effects of individual differences in aptitude, working memory and intelligence on L2 narrative production at four levels of reasoning complexity in Niwa (2000)

	Narrative production							
	Accuracy	Fluency					Complexity	
Reasoning Complexity	EFT	TIME	WPS	SBP	WPP	WPT	SPT	TTR
Narrative 1 (simple)	ns.	Apt* -.48	ns.	ns.	ns.	ns.	ns.	ns.
Narrative 2	ns.	Apt* -.5	ns.	ns.	ns.	Apt* -.59	ns.	Apt** .61
Narrative 3	ns.	Apt* -.42	ns.	ns.	ns.	ns.	ns.	ns.
Narrative 4 (complex)	Int* -.45	Apt* -.44	ns.	Apt/*WM* -.45/-.55	WM* -.47	ns.	ns.	ns.

key: * = $p < .05$ ** = $p < .01$ EFT = % error free T-units TIME = time on narrative WPS = words per second SBP = seconds between pauses WPP = words per pause WPT = words per T-unit SPT = S nodes per T-unit TTR = type token ratio Apt = Aptitude (LABJ) WM = Working memory Int = Intelligence (WAIS-R)

3.1. Comments on the Task Design Findings

The accumulating findings, frameworks for research, and developing research agendas in the areas described briefly above are promising for those concerned with basing pedagogic decision making about optimum L2 learning conditions, task types, task sequencing decisions and on-task 'focus on form' interventions on an empirical footing. The prospect is there that sustained research of this type will be able to show us, for example, which L2 forms benefit most from relatively implicit or indirect negative feedback techniques, such as recasting (Doughty, 2001), and which forms need more explicit interventionist techniques to be acquired, such as those described as processing instruction (Van Patten, 1996).

What is additionally needed, and what some research has begun to examine, is the interaction of instructed L2 learning under different conditions of exposure, via different focus on form techniques, and via practice on different types of task at different levels of complexity, with individual differences in the cluster of abilities contributing to aptitudes for those specific L2 learning conditions, techniques and tasks. It is to describing frameworks for describing aptitudes that can be matched to these variously specified L2 learning conditions that I turn to below.

4. Contemporary Approaches to Aptitude(s)

The issue then is how best to describe the individual difference factors, and their combinations, in such as way as to define sets of aptitudes, or optimally conducive sets of abilities for learning (becoming aware of the input, and subsequently elaborating and processing it at higher levels than those of initial registration) under one condition or another. Conventional aptitude tests such as MLAT are not well suited to this task, since they were developed to be parsimonious (so consisting of a small number of subtests), optimally predictive tests of global learning over schooled courses of instruction (and so not designed, other than indirectly, to measure the processing demands of tasks, and focus on form techniques, and learning processes at the levels of temporal granularity I have described above). Carroll's model of aptitude is based, after all, on a model of school learning (1962), following years of instruction in audiolingual language programs during the 1960s, not in contemporary L2 classrooms, as it occurs during learning on different communicative tasks, or following cycles of them, or following different interventionist techniques for giving feedback.

As Skehan argues (2002), and as some of the studies reviewed above show, no doubt the subtests of MLAT (a paired associate learning measure of *rote memory*; a sound symbol measures of *phonetic sensitivity*; a number learning measure of *inductive learning ability*; and a words in sentences measure of *grammatical sensitivity*) and similar aptitude batteries such as Pimsleur's PLAB, or Sasaki's LABJ, do capture *some* of the abilities that contribute to learning in contemporary communicative and immersion classrooms. There are a number of other, longer term, studies showing this, e.g., Ranta (2002), and Harley and Hart (2002), and studies also showing that the words in sentences subtest of MLAT is a particularly good measure of metalinguistic ability, which has been shown, interestingly, to correlate significantly and positively with L2 learning by post-critical period learners, but not with learning by those with substantial amounts of pre-critical period exposure to the L2 (see DeKeyser, 2000; Harley & Hart, 1997, 2002; Ross, Sasaki & Yoshinaga,2002). Nonetheless, there is a need to develop more contextually sensitive measures of aptitude if progress is to be made in linking individual differences in cognitive abilities to the daily conditions of classroom learning and practice in a useful way.

4.1. Robinson's 'Aptitude Complex/Ability Differentiation' Model of Aptitude

Robinson, adopting the interactionist approach of Snow (1987, 1994) identifies a number of 'aptitude-complexes' or combinations of cognitive abilities that he argues are differentially related to processing under different conditions of instructional exposure to L2 input, and therefore that strengths in one or another of these complexes of abilities can be expected to be important to learning from one instructional technique, or under one condition, versus another. Sternberg has commented on his own attempts to learn three different languages—with very different degrees of success—that ' ... my aptitude was not internal to me, but in the interaction between my abilities and the way I was being taught' (2002, p. 13). Robinson's model of L2 aptitude for instructed learning is an attempt to specify the information processing details of this observation, and to relate them to current issues in SLA theory and pedagogy. There are two closely related hypotheses that define Robinson's basic framework, and he attempts to show how, taken together, they make predictions about how to optimally match learners to instructional options (for expanded discussions of the framework, see Robinson 2001c, 2002a)

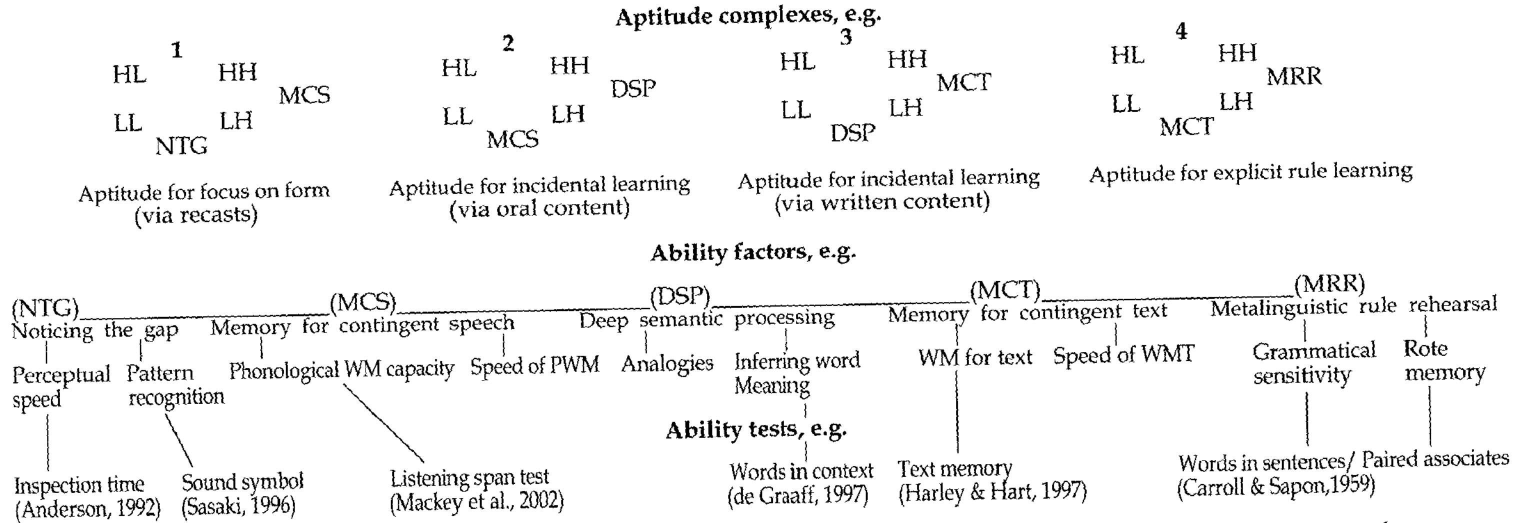
4.2. The Aptitude Complex Hypothesis

The first Aptitude Complex Hypothesis (based on proposals by Snow, 1987, 1994) claims that certain sets or combinations of cognitive abilities are drawn in learning under one condition of instructional L2 exposure, versus another. Figure 4 operationalizes instructional options, and options in types of practice condition, in terms of techniques for intervening during classroom activity to focus on form, either by *recasting*, providing orally or typographically salient *input floods* to enhance forms and so facilitate incidental learning, or via *rule explanation*, as it may occur during Input Processing instruction. Not all learners can be expected to have equivalent aptitudes for learning from each of these options. It follows therefore that if the effects of practice are to be optimized for individual learners, then practice should take place under those conditions to which their aptitudes are best matched. The details of how aptitude complexes can be matched to these instructional options are motivated in part by findings from the laboratory and focus on form research reviewed above, as the following discussion illustrates.

Figure 4 describes four *aptitude complexes*, each made up of different combinations of ability factors. Aptitude complex 1, for learning from *recasting*, is made up of the abilities for noticing the gap (NTG) between the recast and the learner's prior utterance (see Schmidt & Frota, 1986), as well as memory for contingent speech (MCS). These two abilities are argued to be important to holding the interlocutors recast in memory, while comparing it to the learners prior utterance, and also noticing critical formal differences between the two. These *second order* ability (NTG and MCS) factors contributing to this L2 aptitude complex are themselves combinations of domain neutral *primary abilities* such as perceptual speed and pattern recognition (in the case of noticing the gap) and phonological working memory capacity and speed (in the case of memory for contingent speech).

Figure 4

Hierarchical model of cognitive abilities showing two levels of ability factors (primary abilities, and second order ability factors for language learning aptitude), and ability tests used as markers for the central ability. Aptitude complexes at the top are intended to suggest combinations of abilities drawn on under particular learning conditions (based on Snow, 1994, Figure 1.1, p.10)



Key: HH= high, high: LH= low, high: HL= high, low; LL= low, low: NTG= noticing the gap; MCS= memory for contingent speech; DSP= deep semantic processing; MCT= memory for contingent text; MRR= metalinguistic rule rehearsal; WM= working memory; PWM= phonological working memory.

This model, then is hierarchical in its organization of the structure of abilities, in the tradition of Cattell (1976) and Carroll (1993), while also capturing the insight of Snow (1994), that specific combinations of abilities (aptitude complexes) may be related to specific options in L2 instructional exposure.

Figure 4 also relates primary abilities hypothesized, for example, to underlie the second order ability to notice the gap (NTG), to *specific tests* of these primary abilities. In the case of *perceptual or basic processing speed* a test of inspection time, as described in Anderson's (1992) work is proposed, while in the case of *pattern recognition*, the sound symbol correspondence—or phonetic sensitivity—subtest of Sasaki's LABJ aptitude battery is proposed. Evidence for the strong relationship between performance on the LABJ sound symbol test of phonetic sensitivity and learning from recasts was discussed earlier (i.e., findings of Robinson & Yamaguchi, 1999, described in Table 4). In the case of memory for contingent speech, the listening span test of working memory used by Mackey et al. (2002) is proposed as a suitable test of phonological working memory capacity—one of the contributory primary abilities. As also described above, this measure has also been shown to positively predict the ability to notice and learn from recasts during L2 interaction by Mackey et al. (2002).

The second aptitude complex in Figure 4, for incidental learning from oral input containing a flood of particular forms, is made up of the ability factor memory for contingent speech (MCS) described above, and also deep semantic processing (DSP). This second DSP factor contributes the ability to process the semantic content of input containing the flooded item(s) deeply—and may be measured by tests of the primary ability to infer word meaning (as was used in DeGraaff's 1997 study, described above) or to construct analogical representations of meaning, and so establish greater semantic coherence between aspects of the input (see e.g., discussion by Sternberg, 1985 of analogical reasoning, and tests of these). The third aptitude complex, for incidental learning from floods provided in written input, differs only in that memory for contingent text (MCT), rather than speech, combines with DSP to contribute to this complex of abilities for learning.[1] Finally, Figure 4 illustrates a fourth aptitude complex—aptitude for learning from a brief rule explanation, supplemented by examples written on a classroom board, and then applying the rule (while remembering and rehearsing it) in subsequent comprehension (as in input processing instruction) or production activities. This aptitude complex is made up of the secondary abilities memory for contingent text, as well as metalinguistic rule rehearsal (MRR). This last MRR ability factor is proposed to be measured well by two existing subtests of aptitude: the MLAT words in sentences/grammatical sensitivity and paired associates/rote memory subtests, and Table 3, reporting findings for strong significant positive correlations of rule instructed learning with performance on these subtests in Robinson 1997a, supports this claim.

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[1]The framework described here also has potential explanatory value in light of current research into focus on form, and its effects on learning in the short and longer term. Doughty and Williams (1998, p. 236) reporting results of White's input flooding experiment (1998) comment that 'input flooding alone may not be particularly effective', in light of White's lack of substantial findings. But as Figure 4 illustrates, the abilities contributing to aptitude complex 3, for incidental learning from an input flood while processing for textual meaning, may be differentiated in any learning population, such that those with strengths in both DSP and MCT as I have described them, would benefit more from this focus on form technique than those with low abilities in these.

Controlling for the effects of individual differences in the abilities drawn on by different focus on form techniques will therefore be an important part of establishing the effectiveness, or not, of the technique, for any population of learners. Such research will also help establish what it is in cognitive terms that *causes* the effects (or not) of any focus on form technique, by revealing what cognitive abilities inhibit, or facilitate the putative cognitive processes the technique draws on. Such is the case also with the example of recasting, which Doughty has claimed draws on the acquisitional process of 'cognitive comparison' (Doughty, 2001). As with the example of input flooding, populations of learners in studies of recasting may have widely differentiated abilities in the aptitude complex for learning from this technique, accounting for the wide within treatment group variation, and therefore the lack of significant control group comparisons in some studies. Research by Mackey et al. (2002) in particular suggests this may be so.

The findings for low, *nonsignificant* correlations of performance on these subtests and *incidental* learning in Table 3 also supports the separation of this MRR ability from aptitude complexes 2 and 3 for incidental learning and practice in meaning focused conditions, as shown in Figure 4.

4.3. The Ability Differentiation Hypothesis.

The second part of this framework, the Ability Differentiation Hypothesis, is based on findings described by Deary, Egan, Gibson, Austin, Brand and Kellaghan (1996) as well as work on language-based learning abilities and disabilities by, amongst others, Ganschow and Sparks (1993) and Grigorenko (2002). Work on language-based learning disabilities and developmental dyslexia (see the review in Grigorenko, 2002) has shown that some learners have extensive L1-based impairment to, for example, phonological working memory capacity, or specific difficulties in mastering morphosyntactic paradigms in their native language, and Ganschow and Sparks (1993) further argue that such L1-based disabilities underlie poor aptitude for L2 learning. Deary et al. (1996) have also shown, in the field of general intelligence research, that when comparing adults and children, or high IQ with low IQ groups, performance on the subtests of traditional measures of intelligence (such as the Wechsler Adult Intelligence Scale) is more differentiated (i.e., there are multiple abilities, and a weaker general factor or 'g') for adults and high IQ groups than for their child, and lower IQ counterparts. These findings suggest, then, that patterns of strengths in abilities contributing to aptitude complexes in Figure 4 may also be very differentiated for some L2 learners, such that the noticing the gap ability is high, while the memory for contingent speech ability is low. This possibility is captured in the top right HL quadrant in aptitude complex 1 in Figure 4. Alternatively, strengths in both NTG and MCS may be high (HH), meaning recasting is a particularly suitable option for focussing on form for these learners; or strengths in both of these factors may be much lower (LL), suggesting that either alternative focus on form techniques are more suitable, or that some remediative training in developing the abilities in question may be (if possible) a necessary option.[2]

In summary, the Ability Differentiation Hypothesis therefore claims that some L2 learners may have more clearly differentiated abilities—and so strengths in corresponding aptitude complexes—than others, and further that it is particularly important to match these learners to conditions of practice which favor their strengths in aptitude complexes, in contrast to other learners who may have less differentiated abilities, and equivalent strengths and aptitudes for learning under a variety of conditions of exposure and classroom practice.

5. Further Comments and Conclusions

In line with Snow's view of aptitude, described at the beginning of this paper, Robinson's framework describes aptitudes for learning and practice as variegated, but constrained by a theory of the learning

[2]The issues of trainability and dynamic testing can be raised in relation to the Aptitude Complex/Ability Differentiation framework described here. The tests of primary abilities contributing to aptitude complexes suggested in Figure 4 are essentially *static tests* of *existing* abilities, and so may not fully capture the extent to which they are modifiable, and can change during adaptation to, and practice in, a learning environment. That is, in much the same way traditional tests of language learning *achievement* draw on analytic knowledge of the language *system*, or identify abilities in component reading and listening skills outside of real-world language use which synthesizes them (see Robinson & Ross, 1996), these tests of abilities for *future language learning* may not reflect the way they are drawn on by, and develop and adapt to, the conditions of real world *performance*. As was suggested above with respect to Skehan's model, and as is suggested by research into dynamic testing and the modifiability of learning potential (Sternberg & Grigorenko, 2000), *dynamic tests*—involving simulated, on-line measures of tutored ability to learn from e.g., recasts, incidental exposure to an input flood, or rule explanation—may also be necessary to a complete profile of the strengths in abilities, and aptitude complexes, that learners bring with them to the learning context and conditions of practice they implicate.

situations they operate in. In the first half of this paper, learning situations were described at three levels; the level of implicit, explicit and incidental learning conditions; the level of specific options in types of pedagogic task; and the level of options in focus on form techniques. The framework thus draws on the findings reported earlier in this paper from the laboratory, task design and focus on form studies to motivate a number of the claims about the primary and secondary abilities contributing to aptitude complexes.

In the cases illustrated by Figure 4, instructional contexts in which opportunities for practice occur interact with aptitudes to affect learning from exposure and further practice. There, instructional contexts for learning and practice are described in terms of options in focus on form techniques, and options in focus on form techniques are not infinite (see Doughty & Williams, 1988) and so, I have argued, matching aptitudes to conditions of practice which deliver focus on form via one or another of these techniques is a manageable research program, with forseeable beneficial results for learners. However, situations could also be described in terms of the specific features of task design described in Figure 2 contributing to the cognitive demands they impose on the learner. The important further question is, 'How are individual differences, and aptitude complexes for practice and performance on specific tasks to be theorized and researched?' Again, the starting point must be a theory of contexts, and options described in Figure 2 for manipulating the cognitive demands of tasks are not infinite, making this, too, a manageable research program.

Niwa's study (2000) suggests individual differences have most effect on performance and learning on L2 tasks which are complex. This general finding is in line with much of the work of Snow and his colleagues on the relationship between abilities and academic tasks in a variety of domains (Corno et al., 2002; Snow, Kyllonen & Marshalek, 1984). Ackerman and Cianciolo (2002), for example, reporting results of a recent study of air traffic control verbal task performance, comment that ' ... some task characteristics, as can be determined from cognitive task analysis, are important determining factors for ability performance relations. The most salient in the current investigation is that of task content-complexity' (p.207). However, it is also possible to chart the interaction of strengths and weaknesses in the abilities contributing to aptitudes, with *specific* design features of L2 tasks. With the framework described in Figure 2 for L2 cognitive task analysis in mind, it is likely that research into individual differences in the ability to 'switch' attention between task components described by Segalowitz (2001, 2002; see also Rubinstein, Meyer & Evans, 2001) could be an important component of the aptitude complex for learning and performance on L2 tasks which increase in complexity on the single to dual task dimension, where this dimension is operationalized as tasks requiring only one component step (e.g., describing a route already marked on a map) to tasks requiring two simultaneous steps (thinking up the route, while also describing it—see Robinson, 2001a for such a study). Similarly, a number of measures of reasoning ability exist (see e.g., Schaeken, De Vooght, Vandierendonck & Y'deWalle, 2002; Stanovitch, 1999) which could be adapted to assess aptitudes for performance and learning on the -/+ reasoning demands dimension of complexity. The essential principles (aptitude complexes and ability differentiation) of Robinson's framework could therefore be applied in developing measures of aptitudes for *task* performance, practice and learning. Such work would illuminate the extent to which learner's perceptions of the difficulty of the task inhibit, or accentuate task-based language processing (Robinson, 2001a, 2001b, 2002d, 2002e, 2002f) and provide a basis for matching learners' patterns of abilities to those types of task which facilitate processing and learning—thereby optimizing periods of exposure and task-based language practice.

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