COMPLEXITIES OF CLASSROOM LANGUAGE: TEST OF A CAUSAL MODEL

by

Judith Colleen Lapadat

M.Sc., University of British Columbia, 1983

THESIS SUBMITTED AS PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

in the

Faculty of Education

SIMON FRASER UNIVERSITY

DECEMBER, 1992

APPROVAL

Name: Judith C. Lapadat

Degree: Doctor of Philosophy

Title of Thesis: Complexities of Classroom Language: Test of Causal Model

Examining Committee:

Chair: Adam Horvath

Philip H. Winne
Senior Supervisor

Judith Scott
Assistant Professor

Kelleen Toohey
Associate Professor

Jack Martin
Professor

Ronald W. Marx
Professor
Educational Studies
School of Education
University of Michigan
[redacted]
External Examiner

Date Approved Dec 7 1992

Title of Thesis/Project/Extended Essay

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Author: ______________________
(signature)

Judith C. Lapadat
(name)

Dec 7 1992
(date)

ABSTRACT

The last two decades have seen extensive and productive empirical research into the language of primary school classrooms. One important focus in this research has been the ways in which teachers' uses of language in lessons link to students' learning. These linkages have been investigated by researchers in two research traditions--the sociolinguistic/ethnographic approach and the process-product approach. Conceptions, methodologies, and findings from these two research traditions were reviewed, recent calls for convergence were critically examined, and a causal model informed by findings of both traditions was proposed and tested.

Links between students' language ability, two characteristics of teachers' language in a lesson (pace and redundancy), students' attention, and achievement were causally modelled and tested. Students included 120 grade 1, 2, and 3 boys and girls of high, average, and low achievement. All students were administered the receptive vocabulary subtest of the *Test of Language Development* to assess language ability/proficiency. Groups of six students in a school resource room listened to an instructor deliver a 6- to 10- minute lesson about chipmunks in one of four instructional language conditions. Pace and redundancy of the instructional language were systematically varied to produce fast nonredundant, fast redundant, slow nonredundant, and slow redundant conditions, while retaining identical lesson content. Students were videotaped during the lesson, and a measure of attention during the lesson was obtained for each student by calculating percent of visual orientation to the instructor. Students' learning was measured using a multiple-choice task presented in pictorial format and, following group discussion and drawing activities, verbal recall was assessed in an individual interview.

Path analyses showed that students' scores on the multiple-choice task were accounted for by their prior language ability/proficiency and by pace of the instructional language, mediated by attention ($R^2 = .26$). Verbal recall was accounted for by language ability and performance on the multiple-choice task ($R^2 = .22$). The theorized causal model was partly supported but found to be inadequately specified.

One of the most interesting findings concerned the mediating role played by attention. Across the full sample, while slow-paced instructional language and attention both were positively related to the learning outcomes, students attended less to slow-paced instruction. When students identified by their regular teachers as having special learning needs were examined separately from average students, markedly different patterns were found. Students with special needs attended most and obtained their best learning outcomes (equivalent to those of average students) in fast-paced conditions, but both attention and learning declined as pace was slowed and redundancies were added. In contrast, average students' attention dropped only slightly as pace was slowed and redundancies were added, and their learning outcomes increased. These findings are consistent with an attention deficit explanation and a cognitive resource allocation explanation. Implications are that teachers ought to modify their instructional language depending on characteristics of their students, the learning task, and their educational aims.

ACKNOWLEDGEMENTS

Thank-you to my wonderful committee, Phil Winne, Judy Scott, and Kelleen Toohey. You provided me with the right mix of autonomy, advice, and encouragement.

I am grateful to Linda Hof for assistance with videotaping, Chris Speropoulos for reliability coding, and Larry Wiebe for writing the attention coding program.

I feel I have had three mentors at various stages of my progress through this doctoral program: Jack Martin, Ron Marx, and Phil Winne. Thank-you for teaching me the academic ethic.

Finally, to my dear family, Harold Janzen, Katherine, and Erica: you are the ones who make everything worthwhile. I could not have done it without your support and love.

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CHAPTER I

OVERVIEW AND INTEGRATIVE REVIEW OF THE LITERATURE

Overview

The purpose of the study was to test a causal model of the relationships between students' language ability or English language proficiency, characteristics of instructional language, students' attention to expository instruction, and learning outcomes with year three primary (grade two) students. The central idea behind this model is that, as language is the primary medium of instruction, students need to be able to understand what the teacher says to learn effectively in classrooms. However, the communicative environment of typical classrooms, the instructional language used by teachers, and the level of language competence of primary school students interact to result in some students often not understanding, with consequences for their academic learning. Furthermore, these causal links are likely mediated by ongoing processes such as students' changing engagement in instructional tasks or their attention to instructional language.

Following the overview, this chapter begins with a review of research on language learning and the nature and demands of classroom discourse. Then, consequences of language failure for students are discussed. Two programs of research which have investigated links between language and learning in classrooms are the sociolinguistic/ ethnographic approach and the process-product approach. Findings pertinent to the present study, and contributions and limitations of each of these two approaches are discussed. This section ends with a selective review of recent research employing designs that converge in conception, purpose, or methodology.

The second chapter includes further discussion of the purposes of this study. I posit a dynamic and interactive model of teaching and learning, and show how this model can be integrated with an expressive-receptive model of communication and with an information processing cognitive model. Additional empirical research is reviewed and rationales for including each specific element in the model are presented. In particular, the possible mediating role of attention is explored. The causal model to be tested in the study is presented. This chapter ends with a statement of the research questions.

The third chapter is the Method chapter. I describe the 120 primary program students, and pilot studies, measures, instruments, tasks, and procedures of the study. In the fourth chapter, the results of the study are presented. As well as partial support for the a priori causal model, results include postulated alternative causal models, a multivariate analysis of covariance, descriptive, correlational, and univariate analyses, contrasts between teacher-identified special needs students and "regular" students, and qualitative profiles of four selected participants. Chapter five presents discussion and intepretation of the findings. In particular, the strengths and weaknesses of the a priori causal model in explaining factual learning of the particular students who heard this study's expository lesson are addressed. The mediating role played by attention is explored. Differences between students with special needs and other students are analyzed, and their theoretical and practical implications are discussed. Issues surrounding the potential for integrating research findings from different research traditions in convergent studies are revisited. Limitations of this study and directions for future research are identified. The chapter concludes with a summary of the major points addressed.

Language Acquisition

Perhaps the most important finding from the language acquisition research of the last two decades is that the ways people talk to language learners affect the rate of their language learning (Cross, 1978; Snow, 1977). Yet language learning is not a unidirectional process in which language knowledge flows directly from parents to children or from teachers to students. Language is interactive, and language learning occurs within a conversational context (Newport, Gleitman & Gleitman, 1977; Keenan & Schieffelin, 1976; Snow, Midkiff-Borunda, Small & Proctor, 1984). Within a conversational context, the moment-by-moment objective of each participant in the discourse is the negotiation of shared meaning (Bates, 1976; Cazden, 1988; Newport, Gleitman & Gleitman, 1977). The primary reason small children listen or talk at any particular moment is to communicate, not to learn something about language, although, to be sure, much language learning takes place as a result of these communicative exchanges, and sometimes talk is strictly for the purpose of language learning.

The Classroom as a Language Environment

There are marked differences between the language environments of typical classrooms and those of preschool-aged language learners (Heath, 1978; Morine-Dershimer, 1985; Nelson, 1984; Tattershall & Creaghead, 1985). Using language to reach shared understandings in conversations becomes backgrounded to pedagogical purposes of using language in classrooms. Edwards and Mercer (1986) explain that teacher-dominated patterns of classroom discourse arise because "teachers know things and have to teach them; children know less and have to learn" (p. 197). Language becomes an explicit objective of formal instruction, and language is also the means of instruction. A teacher uses language to provide particular information or "facts" (declarative knowledge), to give instructions about "how to" (procedural knowledge), including how to behave, and to prompt students to engage in particular kinds of thinking or learning strategies (strategic or metacognitive knowledge) (Gagne, 1984; Wilkinson & Calculator, 1982).

Cook-Gumperz and Gumperz (1982) describe schooling as a process of social transmission of knowledge that depends on the day-to-day reality created by the communicative interactions of teachers and students in classrooms. Students have access to this knowledge through their ability to participate communicatively, thus they must be competent in using language within the social and situational context of the moment to interpret and contribute to what is said.

In classroom discourse, as compared to conversations, there are different and complex contraints on language use (pragmatics). For example, in most classrooms, the teacher does most of the talking, and each student is often just one of many listeners. Opportunities to talk are limited, opportunities to initiate talk are even more limited, and when students do talk, topic domains are constrained (Cazden, 1986; Edwards & Mercer, 1986; Merritt, 1982; Tattershall & Creaghead, 1985). A student entering school needs to learn which communicative roles are appropriate in a variety of classroom situations, and to understand complex pragmatic rules and indicators that regulate language use in those situations (Cazden, 1988; Ervin-Tripp, 1982; Lapadat, 1991a; Morine-Dershimer, 1985).

Prior to entering school, much of the communicative interaction children have experienced has occurred within conversational dyads. These one-to-one conversations present maximal opportunities for speakers to receive feedback from their listeners and to adjust their language accordingly, so that the listener is better able to understand. For immature language users, this one-to-one interaction maximizes opportunities for communicative success while simultaneously promoting language learning through the shared negotiation of meaning. Competent language users adjust their language in response to feedback they receive to help less competent young communicative partners understand, and in so doing, provide language that is tailored for language learning. At the same time, dyadic conversation is the situation in which it is most likely that young speakers will be attended to and understood, and thus receive payoffs for their attempts to communicate linguistically (Atkinson, 1979; Bates, 1976; Cross, 1977; Snow, 1977).

When children enter school, most linguistic communication occurs in groups rather than in conversational dyads. The teacher talks while the whole class listens, or a student answers a question posed by the teacher while the rest of the class listens. When students work in small groups, several students communicatively interact. Opportunities for one-to-one conversations are few and brief (Jones, 1988; Merritt, 1982). A consequence of this is that language is less precisely tailored for any particular student.

Routines and structures within classrooms typically serve to constrain communicative interactions to those that are expected and appropriate. "Children learn to function, communicatively, as members of an organized social unit: to follow conventional procedures for 'bidding' for a teacher's attention: to recognize teacher's authority to grant permission to speak: and generally to exercise self-restraint in making their demands, requests and responses" (Edwards & Mercer, 1986, p. 175). Brophy and Good (1986) report that much instructional time fits into a recitation teaching model of instruction. A teacher teaches a lesson to a whole class, then provides time for recitation and guided practice, and then the students proceed to independent practice (seatwork). This recitation model of teaching is less predominant but still common in British Columbia following recent changes to the primary program.

A recitation teaching approach influences communicative interactions. The teacher's communicative role is more important relative to other communicative partners' roles, which changes the reciprocal nature of communicative interaction. There are limited and specific functions to which students' language is supposed to conform during each phase of the lesson. They should listen and not talk during the instruction phase. They should give answers, recite, or perform procedures in front of the class during guided practice, or listen and watch if a classmate is reciting or demonstrating. Although they may ask questions or request help, they should generally work quietly without talking during independent practice, or, in small group work, use language to exchange task-specific information with peers. Considerable pragmatic linguistic knowledge is needed for students to carry out these roles appropriately.

While the recitation or traditional model of whole-class instruction curtails the amount of talking students do, when they talk, what they ought to talk about, and how they ought to say it, students also use language for social rather than academic purposes. This social language usually takes place within conversational dyads. However, teachers often try to limit such student-student conversation as it is seen as incompatible with their teaching goals.

Consequences of Not Understanding

Children know a great deal about language by the time they enter school, but they are not yet mature language users. Forty percent of a sample of students interviewed by the British Columbia Royal Commission on Education reported that one of their main problems with school was understanding what their teacher said (Marx & Grieve, 1988). Students who made this claim were mostly young (primary program) students, speakers of English as a second language, or special needs students. The conversational contexts of communicative interaction that most children experience prior to entering school may compensate for and reduce the impact of not having fully developed language competence. In contrast, the nature of classroom discourse might make these supports less available, thus reducing some students' communicative success (Nelson, 1984).

For example, in a conversation, a communicative partner can carry a greater share of the conversational load and meaning is still successfully negotiated. If shared meaning is not achieved, often the conversational partners simply pass onto a new topic with no major consequences. In addition, the meaning often can be successfully inferred from context, as much of the language of young children and their caregivers is about the "here and now" (Snow, 1977).

Young children, children learning English as a second language, and children with language disorders might have difficulties understanding spoken language in classrooms (Green & Harker, 1982). In whole-class or large group interactions, teachers have less opportunity to adapt instructional language to any particular child to compensate for difficulties understanding. As I have suggested above, there are few opportunities for extended one-to-one conversations between teacher and child, and also opportunities for one-to-one conversations with other children are limited. Furthermore, context provides less assistance in clarifying meanings expressed through language, especially as schoolwork becomes more abstract and less grounded in the here-and-now, or in routines and activity structures familiar to the child (Blank & White, 1986).

Failure to understand has important consequences. Students who do not understand instructions cannot do the task at hand, and if they do not do the task, they do not have the opportunity to practice skills and rehearse information. School learning is sequenced, hierarchical, and cumulative (Bruner, 1966). If students do not understand the content of lessons presented by the teacher, they are unlikely to succeed at current academic tasks, and they fail to acquire information and skills they need for the next, more sophisticated task. If they do not understand the content of today's lesson, they will have difficulty understanding tomorrow's lesson that builds on today's. When we view this learning process as constructive rather than merely receptive, it is still obvious that students need to be able to understand the language of the classroom to construct their knowledge within academic domains.

Difficulties in understanding language in the classroom are often accompanied by expressive language difficulties, compounding the academic consequences for some students. For example, in guided practice, some students with language disorders might not be able to verbally express the right answer even when they know it. Or, they might be less likely to request help when they need it because their levels of metalinguistic or metacognitive knowledge limit their abilities to recognize that they need help, and pragmatic language deficiencies limit their abilities to formulate help requests (Lapadat, 1991a). Language difficulties might also put them at a social disadvantage with their peers, as many school activities are competitive and foster social comparisons (Donahue, 1983; Goldman, 1987; Prutting, 1982).

Students who have difficulties understanding and participating in the spoken language of the classroom are also likely to be disadvantaged in activities involving higher level language demands. They lack prerequisite knowledge to develop many higher level language skills. This has serious academic consequences, as much of schooling is about developing higher level language skills (Roth & Spekman, 1989). For example, these students might have difficulty understanding written language (reading) if their knowledge of oral language is deficient. They might have difficulty producing written language. They might also have deficiencies in metalinguistic abilities (abilities to reflect about language) necessary for meeting many of of the linguistic demands of the classroom, especially in reading and writing tasks (Bialystok & Mitterer, 1987).

Unfortunately for these students, teachers, parents, and the students themselves might recognize neither how problematic language is for them nor the inherent complexity of classroom language demands. Students who can follow one-to-one conversation, carry out simple commands, and talk in sentences are described by teachers as "understanding everything I say" and "talking just fine." So behaviors that follow from not meeting classroom language demands might be misinterpreted by teachers as evidence of lack of effort or even of willful misbehavior. As Edwards and Mercer (1986) note, "mismatches between teacher and child language are particularly significant where they are unrecognised, where they create misunderstandings or false attributions of stupidity" (p. 201). Children may be reprimanded for "not listening," "not paying attention," or "not getting their work done" when, in fact, they are not understanding what the teacher is saying (so they stop paying attention), or they don't understand what the assigned task is (so they engage themselves in other activities instead of doing the worksheet).

One consequence for students who don't understand much of the language in the classroom is that less learning takes place. Students who need to work the hardest work the least. For example, language-disordered students are likely to be engaged in less academic learning time (time working on tasks that are at an appropriate level of difficulty) than their more successful peers. A continuum of language failure might then develop (Kamhi & Catts, 1989; Maxwell & Wallach, 1984; Wallach & Liebergott, 1984). These students might be the same children that will be later identified as learning disabled or reading disabled.

Early failure to learn can have profound implications for students' motivation to engage in school learning. The learning difficulties following from language problems can influence children's sense of self worth, feelings of self efficacy, motivation to learn, enjoyment of school, and development of compensatory behaviors such as acting the class clown, or behaving in a disruptive manner to deflect attention from their inabilities (Maxwell & Wallach, 1984; Stipek, 1988).

As classroom discourse and its role in students' learning is complex, contextual, and multi-faceted, there are no simple prescriptions for teachers and how they ought to use language for instruction. Edwards and Mercer (1986) view learning as "a long process of inculcation into educated discourse" (p.201), and suggest the place to start is with analysis of the situated discourse of classrooms. Berlin, Blank, and Rose (1982) also acknowledge the necessity of deeper understanding of the nature of classroom interaction, and, in particular, instructional language. "Verbally based teaching is the medium of instruction through which all other learning is to be fostered. Given the reliance upon oral language in teaching, clearly a fuller understanding of the language of instruction is necessary if this tool is to be used with maximum effectiveness" (Berlin et al., 1982, p. 48).

But Berlin et al. (1982) also advocate immediate application of what we already know from previous conversational and classroom discourse analyses. They call for teachers to analyse the complexity of language in academic tasks, and to match the level of discussion to children's level of understanding. By adapting their instructional language to students' levels of language proficiency, teachers can promote shared understanding of academic content.

Studies of Classroom Processes: The Language-Learning Link

Educational researchers widely acknowledge that language and school learning are closely linked. An extensive body of work relating language and learning followed from Halliday's identification of functions of language, and his suggestion that students learn language, learn about language, and learn through language (1975, 1977a, 1977b). A main objective of schooling is to equip students to understand and produce written language. Reading and writing, along with arithmetic, constitute core subjects in elementary school instruction. Teachers of primary school students teach students to listen to instruction, not to talk out of turn, and to respond to questions that the teacher poses. These types of language skills and knowledge are thus explicit objectives of school instruction. Teachers also implicitly teach, and students implicitly learn, about classroom discourse, including elaborate rules about what is appropriate to say, and how, when, and to whom (Cazden, 1986; Mehan, 1979; Wilkinson, 1982).

In these ways, language-learning and appropriate language use are goals, or "ends," of school instruction. Language, however, also provides a "means" of instruction. Teachers teach by talking, producing written instructional materials (e.g., worksheets), and by giving written and verbal feedback. Students learn by listening and talking, reading and writing. There are few school tasks for which students' language knowledge is unnecessary and many learning tasks for which students' language knowledge and skills are central.

Researchers from two traditions of empirical research on teaching have contributed to understandings about the links between language and learning in classrooms through study of classroom processes. Sociolinguistic and ethnographic researchers have described "the complexities of language and culture in the classroom" (Morine-Dershimer, 1985, p. 4), and process-product researchers have identified "teaching behaviors that lead to improved student achievement" (Morine-Dershimer, 1985, p. 3). In the remainder of this chapter, I will briefly summarize conceptions, methodologies, and findings from these two traditions that pertain directly to the current study, and present an argument for designing convergent studies that draw upon both traditions (see also Lapadat, 1991b, 1992).

The Sociolinguistic/Ethnographic Approach

Both the sociolinguistic/ethnographic and process-product programs of research on teaching originated, in large part, from an agenda proposed to the National Institute of Education (NIE) in the United States by several panels of researchers and practitioners in 1974 (Brophy & Good, 1986; Morine-Dershimer, 1985). As outlined by Morine-Dershimer (1985), the sociolinguistic and ethnographic agenda for a program of research, proposed by the NIE (1974) panel on Teaching as a Linguistic Process in a Cultural Setting, included the following goals: to "determine the rules governing classroom discourse" (p. 6), to study students' acquisition of rules for school discourse, to "determine the ways in which differences in dialect, language style, and interactional norms affect learning in the classroom" (p. 6), to "describe and analyze patterns of student-teacher communication ... [and their effects] on the acquisition of knowledge and skill" (p. 6), to investigate second language learning, and to "develop and field test materials and procedures to improve teaching, and thereby learning, on the basis of knowledge about linguistic processes in classrooms" (p. 6).

Researchers in the sociolinguistic/ethnographic tradition have emphasized observing, identifying , and describing teacher-student interactions, language use, instructional behaviors, and other classroom events and aspects of classroom context (Cazden, 1986; Evertson & Green, 1986). A central theme has been that learning occurs through linguistic and social interactions between the students and the teacher. Thus, many of these studies have focused on the ways language is embedded in or learned through classroom discourse or communicative interaction. (See Green & Harker, 1982, for a summary of the main objectives, assumptions, and themes of sociolinguistic/ethnographic classroom research.)

Studies of teacher talk. Within sociolinguistic and ethnographic classroom research on teachers' instructional language, several themes can be identified, and I will briefly outline some representative studies. Several studies describe characteristics of teacher talk (see Cazden, 1986, for a review). Heath (1978) describes the teacher talk register as deriving its characteristics from classroom discourse in which it is embedded and from the functions it must serve. For example, teachers talk to regulate children's behavior and their participation in classroom discourse, as well as to instruct and to evaluate. In order to understand what teachers mean, students need to understand both the linguistic levels of meaning and the cultural norms and behaviors to which the teacher is referring. Heath points out that many teachers are not aware of these structural and functional aspects of their own language in classrooms.

Cazden (1988) also described characteristics of the teacher talk register. Teachers talk two thirds of the time. Teachers talk to control behavior and to control classroom talk itself. Both of these observations reflect the asymmetry of classroom discourse.

Green and Harker (1982) have pointed out that, while social rules affect participation in classroom discourse, students' moment-by-moment participation is greatly influenced by the instructional language strategies used by the teacher. In data they collected from two kindergarten classrooms over three years, an analysis of the two teachers' talk showed that 50% and 67% of the total spoken messages were produced by each teacher respectively. Both teachers' talk was similarly complex with respect to number of strategies (e.g., controlling a student's behavior; refocusing a student's attention) conveyed per message. The two teachers' talk was also strikingly similar in types of strategies used. Both teachers were highly goal directed. However, the teachers differed from each other in frequency of use of particular strategies, and in type of language they used to achieve a strategy. For example, the teachers differed in how frequently they provided positive confirmations, and whether they primarily used verbal directives or questions to confirm.

The teachers also differed in types of classroom activities they provided for their students (e.g., show and tell), and some of the teachers' language differences arose from differing tasks they were thus engaged in. Therefore, by regularly providing certain types of classroom tasks, teachers also influenced the type of teacher language students heard and types of discourse opportunities students had. Green and Harker commented that "although two teachers may have similar goals or stated expectations, they may not have similar social and communicative environments for children" (1982, p. 207).

Merritt (1982), in her analysis of teacher talk in ten primary school classrooms, commented on the importance of establishing mutual engagement on the part of teacher and students. She identified two factors that influence this mutual engagement. Teachers' and students' roles are asymmetrical in that teachers can initiate talk with students at any time, but students often are not permitted to initiate talk with the teacher. Secondly, as there is one teacher but many students, "the teacher's time is a scarce commodity" (1982, p. 223). Merritt described types of situational demands on teachers' attention, and communicative skills that teachers use to distribute attention to students equitably. She also described how teachers' strategies for directing students' attention often depends upon the students' ability to use inference, and she noted that teachers use a variety of nonverbal and paralinguistic cues to signal shifts in the focus of the teacher's attention, or that students are expected to redirect their attention.

In her year-long study of 60 children attending bilingual kindergartens and learning English as a second language, Lily Wong Fillmore (1982) was interested in the characteristics of teacher talk as linguistic input. She pointed out that for these students, teachers' language serves two important functions: "it conveys the subject matter to be learned at school, and it provides an important source of input such students need in order to learn the school language" (1982, p. 283). Her emphasis was on the latter function, and she noted that "speech becomes usable as input for language learning only when it has been produced with the learners' linguistic needs and limitations in mind" (p. 283). She suggested that many teachers find it difficult to manage the competing goals of providing input appropriate for language learning as well as using language to convey the subject matter, particularly when they are teaching complex subject matter, and when there are other students in the class who are fluent speakers of English. Her findings were that two characteristics of teachers' language promoted learning of English as a second language; the students needed to receive ample exposure to the target language, and the teachers needed to adjust their language input to be maximally appropriate for language learning.

While many studies of language-disordered or learning disabled students have focused on these students' abilities to participate in and learn rules of classroom discourse (see Lapadat, 1991a, for a review), Mehan, Hertweck, Combs, and Flynn have cautioned teachers against "adopting a generalized deficit view of children who are not succeeding in classrooms" (1982, p. 318). They point to findings about how teachers' expectations can influence students' performance, and observed that there is an "interaction between the beliefs of observers and the characteristics of the people observed" (p. 315).

Contributions. The sociolinguistic and ethnographic program of research has led to deeper understanding about the processes of communicative interaction in classrooms and the roles of teachers' instructional language, especially as related to the structure of classroom discourse, and how students become communicatively competent in classrooms. In addition, sociolinguists and ethnographers of classroom interaction have contributed descriptions and explanations of: characteristics of classrooms that make them unique communicative contexts, classroom discourse and its functions and demands, how students learn to interact with others in classrooms through discourse, and how characteristics of students mediate their communicative interaction and discourse learning. This program of research has provided insights into what actually happens in classrooms on a day-to-day basis: who talks to whom, and when, where, how, and why. (For reviews and summaries, see Bloome & Knott, 1985; Cazden, 1986; Green & Smith, 1983; Morine-Dershimer, 1985; Peterson & Wilkinson, 1984).

Another important contribution is that this work has led to an acknowledgement of the importance of context and to conceptualizations of the multiple layers of context which surround and influence the behaviors of students and teachers continually, and in constantly changing ways. It has become clear that patterns of communicative interaction in classrooms arise out of and interact with contextual factors, and therefore that aggregating data without concern for differences in context can and has led to misconceptions in interpreting research findings (Carlsen, 1991).

By taking an observational approach and emphasizing description, sociolinguists and ethnographers of classrooms have allowed the data to lead them to identifying patterns of classroom interactions. Thus, differences across contexts or individuals have illuminated aspects of particular classroom processes rather than being interpreted as errors to be minimized as has been typical in research involving quantitative large-sample aggregations of data.

Limitations. However, within this tradition, investigations of language-learning links are limited both methodologically and theoretically. By favoring qualitative approaches to investigation, researchers in this tradition have limited many of their findings to descriptions and explanations that cannot be generalized with confidence beyond their data. (See, however, comments by Evertson & Green, 1986, and Erickson, 1986, on what counts as generalizability in qualitative research.) Furthermore, as the data typically consist of intensive study of small samples of subjects, the strength of generalizations one might make on the basis of several such studies is also limited. While some might argue that the value of this approach is that interpretation of findings is grounded by the data, nevertheless, researchers do go on to make general conclusions about the nature of communicative competence, or the ways that students learn discourse rules, and such generalizations from small samples or aggregations of several dissimilar small samples might not be warranted.

Some "holes" in this program of research can also be identified, and it appears that the holes are there because of research questions that have not been asked as they have not seemed to follow from the theoretical assumptions of this approach. One question that seems to have had relatively little investigation by sociolinguists and ethnographers is how aspects of classroom language (the classroom language environment, communicative competence, learning of discourse, and so on) map onto students' academic learning. One reason we are interested in classroom language, after all, is that children's language knowledge and success at participating in and learning classroom discourse presumably has something to do with their success at academic learning at school. Yet relatively few studies within this research tradition have focused on this crucial language-learning link. Investigations of students' learning have more often addressed how students learn to meet the communicative or social demands of classrooms. (Studies of second language learning are an exception, as academic learning has been a central and explicit concern.)

A second issue that calls for more research is that of the consequences for students of variations in teachers' instructional language. As Green and Harker's (1982) and Merritt's (1982) studies show, effects of instructional language are not straight-forward, yet potentially of great importance to students' learning. Questions one might pose include the following. Do teachers adapt their language for students they teach, and how do they manage this, given they are not teaching one student, but many? How do such adaptations of instructional language alter students opportunities for learning? Which characteristics of teachers' language promote what kinds of learning, for which students, and in which contexts?

The Process-Product Approach

Process-product studies come from a different research tradition, and thus reflect different research concerns and methodologies. This program of research is also known as the teaching effectiveness approach (Shulman, 1986), or process-outcome research (Brophy & Good, 1986; Shavelson, Burstein, & Webb, 1986). Process-product studies relate teacher behaviors (processes) to student outcomes (products) (Evertson & Green, 1986). In contrast with the sociolinguistic/ethnographic program of research centering on observations of linguistic interaction in classrooms, process-product researchers were initially concerned with discovering which teacher behaviors were associated with higher student achievement, and more recently, identifying "those cognitive aspects of classroom processes that facilitate student achievement" (Peterson & Wilkinson, 1984, p. 5; see also Marx, 1985). There are two fundamental assumptions of this research program. One is that teacher behaviors influence student behaviors, and that both of these influence student outcomes. The second assumption is that teacher behaviors, student behaviors, and student outcomes can be measured and quantified.

Researchers in this tradition have emphasized quantitative methodologies. Typically, an observation instrument employing low inference measures and counts of discrete behaviors is used to record teacher and student behaviors, standardized tests are used to measure student outcomes, then the behaviors (processes) and achievement outcomes (products) are correlated. Experimental designs are also used.

Over the last decade, researchers have expanded their scope consonant with the methodological objectives identified in the agenda for the process-product program of research recommended by the National Institute of Education Panel 2 (1974). These included the following key considerations:

> programmatic, cumulative research designs; letting the goals of the project, and not habit or convenience, determine what and how to measure; multiple measurement of a variety of outcomes (product variables); considering non-linear process-product relationships; considering complex interactions among variables (suppressor effects, moderator effects, etc.); eliminating or controlling entry-level differences in student ability or achievement; including both high- and low-inference measures of a variety of process behaviors; selecting samples of teachers and classrooms to insure comparability and representativeness; collecting enough data in each classroom to insure reliability and validity (or alternatively, controlling classroom events by standardizing lessons and materials); controlling for Hawthorne effects and monitoring implementation in experimental studies; insuring adequate variance and stability in relevant teacher behaviors in naturalistic studies; taking into account patterns of initiation and sequence in teacher-student interaction; and devising scoring systems that allow for more direct comparison of teachers or students than mere frequency counts provide. (Brophy & Good, 1986, p. 332)

Findings. Early work in this tradition focused on developing conceptions of the effective teacher and comparing the achievements of classes taught with one method with the achievements of classes taught with another method. Few meaningful differences in achievement were found in this early work, however (Brophy & Good, 1986). Since the 1970s, in response to theoretical and methodological guidelines proposed by researchers such as Rosenshine and Furst (1973) and Dunkin and Biddle (1974), and by research Panel 2 at the NIE conference on studies in teaching in 1974, several major programs of process-product research have emerged (Brophy & Good, 1986).

Findings from correlational and experimental research have included several consistent and replicated linkages between teacher behavior and student achievement. Higher student achievement has been consistently linked to: quantity and pacing of instruction, grouping for instruction during beginning reading instruction or in highly heterogeneous classes, provision of information that is structured, redundant, clear, enthusiastically presented, and paced appropriately for the age of the students and the difficulty level of the material, several characteristics of teacher questioning, several characteristics of teacher feedback or reaction to student responses, and methods of handling seatwork and homework assignments (Brophy & Good, 1986).

However, language used in classroom discourse by teachers and students has not been a primary focus of the process-product program of research. Exceptions are a number of studies measuring aspects of teacher talk, and these include Flanders' studies of the quantity and directness of teacher talk (Flanders, 1970), various investigations of teachers' use of higher order and lower order questions (see reviews by Brophy & Good, 1986; Carlsen, 1991; Winne, 1979), and a series of studies by Land and Smith and their associates linking teacher clarity with student achievement (Smith & Land, 1981). Fillion and Wright (1982), in a report reviewing research on language learning and classroom processes (including process-product studies as well as other investigations) summarized findings as indicating students learn more when teachers interact with them a great deal, use open-ended questions, higher-order statements of ideas, and task-oriented statements, and provide regular feedback.

Flanders' premise was that "teachers can analyze their classroom interaction in order to obtain information about the chain of events and especially their own acts of teaching behavior" (1970, p. 1). He characterized teaching as a series of reciprocal social interactions between teachers and students. Flanders coded frequencies of teachers' behaviors and correlated them with students' attitudes and achievement (using whole-class scores). He found little consistency across grades, subject areas, or locations, and within-group correlations tended to be slight to moderate. In explaining his failure to find teacher behaviors that consistently predicted student achievement, Flanders noted that "a single interaction analysis predictor is unlikely to be associated equally well with different outcome variables, different grade levels, and different learning activities" (1970, p. 397). With respect to students' attitudes, Flanders interpreted his findings as showing that students tended to score higher when teachers asked more questions, and clarified and used students' ideas. These same characteristics, along with teacher flexibility, tended to show slight positive correlations with achievement, whereas teacher restrictiveness, restrictive feedback, and negative authority tended to show slight to moderate negative correlations with achievement.

Teacher clarity in presenting lessons has been quite consistently correlated with student achievement (Brophy & Good, 1986). For example, Smith and Land (1981) reported a series of studies in which high school or college students listened to audiotaped lessons to which vagueness terms, mazes (halts, false starts, and redundancies), or discontinuities (content presented out-of sequence; irrelevant interjections) had been added. Each of these reliably detracted from students' achievement across several studies.

The common assumption that students learn better if teachers pose higher-order rather than lower-order questions has not been supported (Brophy & Good, 1986). In his review of research linking cognitive level of questions to achievement, Winne commented that "whether teachers use predominantly higher cognitive questions or predominantly fact questions makes little difference in student achievement" (1979, p. 43). While methodological weaknesses in studies that he reviewed might have contributed to this finding, Winne noted that a central assumption of this research, that higher cognitive questions "get students to recall and mentally manipulate information" (1979, p. 44), had not been empirically documented. He suggested that teachers' use of questions ought not to be linked to student achievement measured after the fact without tracing the intervening cognitive processes of the students.

More recently, Carlsen (1991) reviewed this literature from a sociolinguistic perspective and argued that "there are striking weaknesses in process-product research on classroom questioning" (p. 172). He made the point that researchers within this tradition have "often attempted to draw conclusions about discourse in the absence of an adequate conception of discourse" (p. 172), and he noted that statistical findings have little meaning outside of an explanatory model. He also criticized this body of research for its treatment of context (minimizing contextual factors, or using static rather than dynamic definitions of context), the failure to examine content of questions, and the preoccupation with teacher behaviors to the exclusion of interactive characteristics of classroom discourse. Carlsen's criticisms focus on the paradigm within which classroom questioning has been examined, an issue to which I will return below.

Other aspects of teachers' language use that appear to promote student achievement, as reported in Brophy and Good's (1986) review, include structuring presentations of material "by beginning with overviews, advance organizers, or review of objectives; outlining the content and signalling transitions between lesson parts; calling attention to main ideas; summarizing subparts of the lesson as it proceeds; and reviewing main ideas at the end" (p. 362); presenting key concepts redundantly; pacing lessons rapidly in early grades but slowly in later grades; posing questions that are moderately challenging; waiting long enough for students to respond to questions; providing feedback as to whether students' responses are correct or not; eliciting improved responses to questions; and incorporating students' comments into the lesson.

Contributions. Teachers are in the business of helping students learn, so it is useful to determine what teacher behaviors and actions best promote students' achievement. Process-product researchers have made important contributions to our understanding of teaching and learning, first, by posing useful questions about teaching-learning links, and secondly, by identifying specific teaching behaviors that promote, inhibit, or make no difference to students' learning. While no generic teaching behaviors that universally boost student achievement have been found, the lack of such a finding has led to a deeper understanding that several variables may interact, resulting in differences in teaching and learning across participants and contexts. That is, a teaching behavior of Teacher A that effectively promotes learning for lower class students in an urban second grade classroom might not work for Teachers B's middle class students studying high school mathematics. The process-product program of research has also stimulated rapid progress in developing quantitative methodologies for examining complex, changing, multiple variable data.

Limitations. The contributions of this program of research also point to its limitations. In retrospect, it seems obvious that searching for generic indices of teaching effectiveness without consideration for the individual differences of teachers and learners or for differences in context (e.g. culture, subject matter, classroom organization) was unlikely to yield either strong and consistent generalizations or situationally meaningful results (Brophy & Good, 1986). Both methodological and theoretical limitations to this research can be identified.

A methodological limitation of many of these studies arises from the use of standardized tests as the learning outcome measure. Shavelson, Webb, and Burstein (1986) noted that "according to the paradigm, a teacher is effective if, within the time period studied, students, averaged over the whole class, answered more questions correctly on multiple choice standardized achievement tests than expected, based on pretest performance" (p. 52). Not only have these tests often been administered long after the teaching behaviors were measured, but also what standardized tests measure might have little to do with specific teaching and learning objectives in a particular classroom or with what individual students understand and can do. Standardized tests typically don't reflect much of the curriculum taught, they reveal only mean gains of whole classes, and they are distal from the occurrence of the actual teaching behavior (Shavelson et al., 1986). Thus the use of standardized tests as the outcome measure has tended to minimize findings of effects any particular classroom process might have on students' learning.

The measurements of classroom processes used in process-product studies can also be criticized. Shavelson et al. (1986) questioned the reliability with which teaching behaviors have been estimated and interpreted. They pointed out "the need to assess multiple sources of variation in measurements of classroom processes - observers, occasions, settings - to obtain generalizable samples of behavior" (1986, p. 59). They proposed using generalizability theory to design studies that would avoid this problem. Other concerns discussed by Shavelson et al. include:

> consistency of components of teacher behavior, length of periods for observing teaching behavior versus number of observation periods, the bidirectionality of teacher-student interaction and influence, the assumption of steady-state versus changing behavior over time (linear, nonlinear, unsystematic), and dichotomous observation data. (1986, p. 71)

Winne (1987) argued that process-product methodologies are poorly suited for generating or testing theories that depend on students' cognition to explain process-product relations. He proposed a cognitive mediational paradigm, in which students' mediating cognitions are explicitly examined, to replace the process-product approach.

At a conceptual level, process-product researchers have not explicitly focused on language processes as the medium and means of most classroom learning. Perhaps language interaction of teachers and students has been assumed to be transparent, and therefore bypassed as an object of study. When language has been studied, it has been the teacher's language. Frequencies of general components of teacher talk (e.g., questions) have been correlated with students' average achievement gains. The means by which these components stimulate learning, and for what students and in what contexts, has not been identified. In most of these studies, the target behavior has been isolated and counted, then averaged across students and contexts. Thus, not only have researchers selected overly general components, but they have further limited the interpretations that can be made by isolating these from the contexts and individual participants from which they obtain their meaning.

These limitations arise directly from the conceptions and research questions that guided this program of work. That the link between teacher behaviors and student achievements has been seen as causal and unidirectional delayed the discovery that classroom processes are complex and multidirectional (Winne & Marx, 1977). That research questions and observational categories have been decided on a priori has led to examining questions that may be peripheral or overly general, or slicing up, counting, and interpreting behaviors in ways that don't make sense in context. And that quantitative methodologies have been adhered to has sometimes led to examining behaviors and relationships that are quantifiable, rather than those that are theoretically or practically interesting.

Converging Perspectives and Methodologies

From a practical perspective, consideration of the contributions and the limitations of the sociolinguistic/ethnographic and the process-product approaches to uncovering links between language and learning leads to an interesting observation: the weaknesses of the process-product approach are the strengths of the sociolinguistic/ethnographic approach, and the weaknesses of the sociolinguistic/ethnographic approach are the strengths of the process-product approach. Sociolinguistic and ethnographic researchers have found out a great deal about the nature of classroom discourse and how students learn to engage in it, but have seldom examined how classroom language links to students' academic learning. Process-product researchers have examined classroom process-learning outcome links, but without sufficient consideration of the nature and complexity of those classroom processes, especially processes of classroom discourse. Sociolinguists and classroom ethnographers have described and explained the particular, and thus generalize at their peril. Process-product researchers have measured and related the general, thus reaching conclusions that often aren't meaningful in applications to the particular.

Methodologically, classroom sociolinguists and ethnographers typically have let the data guide their investigations, and have developed grounded theory and a conception of the complexity and importance of context. However, aggregation and integration of findings is problematic for these researchers. Also, by relying primarily on descriptive levels of investigation for theory building, they do not have a way to test their theories, and are obstructed from building strong explanatory or predictive theories. (Researchers in this tradition might counter, however, that methods like microanalysis do support explanatory theory, and that predictive theories and prescriptions for practice have been explicitly avoided because their positivistic and reductionist implications are inconsistent with the interpretivist premises of this paradigm.)

The quantitative methodologies of process-product researchers, with their techniques for checking and maximizing reliability and validity of observations, are designed for data aggregation, for identifying relationships and their strengths, and for testing theories. But the usefulness of these methodologies depends on researchers asking meaningful questions and measuring the processes and outcomes that follow both from the questions and situations under consideration. Preoccupation with measurement has sometimes obscured the need to clearly conceptualize issues and to formulate meaningful questions.

Researchers within each tradition have discussed these kinds of problems and have proposed ways to extend and improve their research methodologies to avoid them or compensate for them while still remaining true to the premises of their research paradigm. For example, Green and Harker (1982) and Evertson and Green (1986) have discussed how to determine what constitutes evidence, and sources of validity in descriptive or observational approaches. Sevigny (1981) proposed using triangulated inquiry, "the comparison of several groups using varied perspectives and multiple procedures at two or more points in time" (p. 73) in classroom ethnographic research to strengthen the potential for making generalizations. Shavelson et al. (1986) proposed generalizability theory as a quantitative way of dealing with the complexities of context, and Winne (1987) proposed adding measures of students' cognitive mediation of classroom events to quantitative process-outcome investigations.

A call for convergence. Another solution, however, is to design studies that draw on both the sociolinguistic/ethnographic approach and the process-product approach in conception or methodology. In its strong form, this could imply a marriage of the questions, conceptions, methodologies, and findings of both approaches. In a weaker form, a "compatible" (Howe, 1988) or convergent approach would call for triangulation across rather than just within approaches, in the pragmatic interest of "what works." And in its weakest form, convergence would simply connote a greater tolerance of pluralism and a willingness to consider and be informed by different perspectives and programs of research. As Gage (1989) suggested, "paradigm differences do not require paradigm conflict" (p. 7), and "programs of research that [have] often been regarded as mutually antagonistic [are] simply concerned with different, but important, topics and problems" (p. 7). And as Carlsen (1991) noted at the conclusion of his review on classroom questionning in which he engaged in "poking fun at process-product research" (p. 173) from the perspective of a self-acknowledged sociolinguistic bias, "a more productive task may be to look further at the ways in which the two paradigms might productively inform each other" (p. 174).

My call for convergence in investigating language-learning links in classrooms is not a new proposal, of course, but, rather, the addition of another voice to a wider, ongoing conversation. The wider issue has often been labelled "the quantitative-qualitative debate," and conceptualized as an argument about whether a positivistic paradigm (which is often considered by participants in this debate to undergird quantitative methodologies) is fundamentally inconsistent with an interpretivist paradigm (said to undergird qualitative methodologies) (Gage, 1989; Howe, 1988; Smith, 1983; Smith & Heshusius, 1986). In special education research, the issue has been framed as a challenge to find a middle ground between the nomothetic, law-seeking approach to science (labelled "simple-minded" by Speece, 1990), and the idiographic approach involving individual description (labelled "muddle-headed" by Speece; see also Brinker, 1990; Deno, 1990; Turnure, 1990).

Those arguing against compatibility posit that these two approaches rest on irreconcilable epistemological differences. These include differing perspectives on how reality is to be construed, what constitutes "truth"or "knowing," and what relationship the researcher has to what he or she investigates (Smith, 1983; Smith & Heshusius, 1986). Those favoring the possibility of compatibility argue that these apparent differences are overstated and that both quantitative and qualitative strands are intertwined in research conducted within both traditions (Howe, 1988), or that these differences can be seen as subordinate to more fundamental shared "moral and rational foundations ... dedicated to the same ideals of social justice and democracy and the goals of an education that would serve those ideals" (Gage, 1989 p. 8). Compatibilists take the pragmatic perspective that it is time "to move beyond a forced choice between exclusive epistemological paradigms" (Howe, 1988, p. 14) to a change of focus "from *whether* combining positivistic and interpretivist elements is legitimate to *how* this combination is to be accomplished" (Howe, p. 14). Gage reminds us that:

> Educational research is no mere spectator sport , no mere intellectual game, no mere path to academic tenure and higher pay, not just a way to make a good living and even to become a big shot. It has moral obligations....The payoff inheres in what happens to the children, the students. That is our end concern (1989, p. 10).

With this brief sketch of the wider debate as background, I return here to a more specific focus on convergence in studies of classroom processes. An approach to investigating classroom interaction that draws upon the conceptualizations, empirical findings, and methodologies of both the sociolinguistic/ethnographic research program and the process-product research program is already emerging. Evertson and Green (1986) have described this as a phase of "theoretical and methodological advances, and convergence across research directions in the use of observational techniques to study teaching" (p.162). They have suggested that quantitative and qualitative approaches are complementary as each single study "captures only a slice of reality" (Evertson & Green, 1986, p. 204). To this research phase, Evertson and Green have contributed a conceptualization of the nature of observation, focusing first on the methods and issues involved in the design and implementation observational research, and secondly on a framework for the process of inquiry.

This converging perspective has also been reflected in Brophy and Good's (1986) review of the links between teacher behavior and student achievement as a concern for the context-specificity of findings, and a call to acknowledge both the power and the limitations of aggregated quantitative data.

Peterson and Wilkinson (1984) have argued for integrating multidisciplinary perspectives, as this strategy can supply additional information to research questions that have not previously been answered conclusively within a particular program of research. In order to bring findings from different perspectives to bear on a particular research question, however, they pointed out that a mechanism that integrates the diverse perspectives is required. To this end, they proposed an integrative model of classroom research (specifically for integrating conceptual issues and findings from various disciplines on the organization and processes of classroom groups). In this model, they proposed links between student diversity and variations in classroom organization, and links between both of these and teacher-student and student-student interaction processes, and links between both student diversity and interaction processes and student achievement, motivation, and social skills. I suggest that with the addition of teacher diversity, and student and teacher cognitions, this model would quite thoroughly capture the central findings of both research traditions.

Designs for convergent studies. Studies can be designed so that they converge on one or several dimensions. Perhaps the most fundamental and essential kind of convergence involves reflecting upon the findings and kinds of research questions being asked by researchers using another approach, and considering ways to ask those questions within the constraints and methodologies of one's own approach. This "weak" convergence is also least straining epistemologically, as it allows for reinterpretation of questions and findings within one's own framework and assumptions. An example of this kind of convergence was employed in a study by Dickson (1982). He began by considering sociolinguistic/ethnographic findings about the centrality of classroom discourse for learning, then designed a strictly quantitative study of referential communication using barrier games to test selected hypotheses about discourse.

A stronger version of convergence involves designing studies that triangulate across approaches by taking multiple measures of a sample or several samples either simultaneously or over time to measure aspects of the same question posed from different perspectives. For example, a researcher could observe and describe naturalistic discourse in a particular classroom (conceptualization and qualitative methodology favored by sociolinguists and ethnographers), and subsequently design a study in the same classroom correlating aspects of each student's discourse participation or learning with a criterion-referenced measure of language arts achievement (process-product conceptualizations and quantitative methodology). An example of this kind of convergence can be seen in a study by Peterson, Wilkinson, Spinelli, and Swing (1984) examining the relationship between students' achievement and small-group interaction processes.

Convergence in its strongest form is probably the most difficult to conceptualize. One possibility would involve mixing and matching methodologies while retaining different conceptualizations about the nature and purpose of classroom research. For example, a researcher could design a study conceptually consistent with his or her usual program of research, but utilizing methodologies drawn from the other approach; that is, a sociolinguist could study discourse quantitatively, or an instructional psychologist could investigate process-product links using participant interviews. Smith (1983) cautions against this view of method as merely sets of techniques, however, and notes that method can also be characterized as "logic of justification" (p. 8). From this perspective, procedures or techniques cannot be blindly applied without thought given to the epistemological implications. Smith says:

> Method as logic of justification, involving as it does basic philosophical assumptions, informs method as technique .... Clearly, if the two perspectives define truth differently, not only must each accept a different conceptualization of validity, each must hold to a different interpretation of the place of procedures in the claim to validity (1983, p. 8).

The other possibility involves conceptual convergence, in which a third perpective is postulated--perhaps pragmatism or symbolic interactionism--that integrates the positivists' pursuit of a measurable objective reality with the interpretivists' subjective value-laden and socially-constructed reality. This might entail an acknowledgement that a socially or cognitively constructed reality mediates the researcher's access to an objective reality. From a positivist's stance, this would lead to an understanding that any inquiry is value-laden, and that much of the meaning of social acts derives from their context. In practice, this could lead to greater attention to identifying, specifying, adjusting for, including, or controlling the influences of such variables, and the fantasy of certitude could be discarded. For an interpretivist, this view might offer a foothold on the slippery slope of relativism, and an understanding that our perceived reality arises from both the inputs of an objective (but not directly accessible) reality and our socially influenced interpretations. This would also allow for the possibility of other warrants than shared belief alone, such as scope, consistency, accuracy, simplicity, and usefulness (Howe, 1988). Following the pragmatists, researchers could simply dismiss the focus on epistemological necessities as unproductive, and turn instead to a focus on utility and practical consequences (Cherryholmes, 1992; Gage, 1989). The interested reader is referred to Lapadat (1992) for a more detailed review of several studies that have attempted some version of convergence.

Conclusions From Two Research Traditions

In recent years, the scope of inquiry has expanded so that the research questions of interest, conceptualizations, methodologies or findings from both the sociolinguistic/ethnographic and process-product traditions are being integrated. Conceptualizations and research design draw upon the findings from both traditions and, at the same time, avoid or compensate for the theoretical and methodological pitfalls from each tradition. Marriage of these two research traditions or, at least, respectful cohabitation, can stimulate the emergence of a new program of work that capitalizes on past findings about classroom language and how it is linked to students' learning, as well as on the conceptual, theoretical and methodological advances of both of the contributing programs of research.

This is particularly important in the study of language-learning links, as classroom discourse is so complex and contextual that findings of quantitative tests of components of the language-learning relationship are bound to be unsatisfactorily reductionistic unless conceived and interpreted within a wider holistic perspective. Similarly, strictly qualitative studies of discourse risk becoming mired in masses of detail, from which generalizations cannot be extracted, and without the tools to relate processes to learning outcomes. Whether our aim is to better understand how classroom language processes relate to students' academic learning, or to derive guidelines for instructional practice, it makes sense to integrate what we have learned from both of these productive traditions of research into classroom language processes.

CHAPTER II

CONCEPTUAL MODELS AND SCOPE OF THE STUDY

The previous chapter included a review of the role of classrooms as language environments, a discussion of consequences for students of not understanding instructional language, and a review of two traditions of research into classroom language processes. In this chapter, the broad purposes of this study are described. I present a dynamic and interactive model of teaching and learning, explain the model with reference to both theories of communicative interaction and information processing, then show how the questions, elements, and design of this study follow from the model. The chapter concludes with the specific research questions examined.

Purposes of the Study

There were three major purposes of this research. One purpose was to design a convergent study drawing upon the findings of both the sociolinguistic/ethnographic classroom process approach and the process-product approach to investigating classroom language-learning links. This was convergence in the weak sense, in that I intended to integrate findings from two perspectives in developing a model of language processes and learning outcomes, and then test a component of this model using quantitative methods. In this way, I hoped to investigate the utility of a convergent research strategy for contributing to practical and theoretical knowledge about classroom language, while also identifying its potential pitfalls.

The second purpose, following from the first, and constituting the central core of the study, was to test a causal model linking aspects of students' language ability or English language proficiency, characteristics of teachers' instructional language, and a process variable reflecting students' ongoing engagement in the instructional activity, with measures of students' learning outcome. This research design drew upon the sociolinguistic/ethnographic process approach in its conception of classroom teaching and learning as involving the rules, roles, processes, and events of communicative interaction. The a priori selection of a component of this model for investigation, the variables focused on, the quantitative methodology employed, and the concern with linkages between communicative processes during instruction and subsequent understandings students developed followed from the process-product approach to classroom research. Quantitative interpretations were tempered, however, with qualifications about how much contextual variables can be controlled or included, and with a willingness to consider the meaning of individual participants' behavior.

The third purpose was to examine closely the interaction of engagement, prior language ability or English language proficiency, and instructional language variations for those students identified by their teachers as having special learning needs, as compared with those not so identified. I hoped to clarify how levels of understanding, engagement in learning, and final content knowledge are related, and how these differ for students with special needs as compared to regular students in various instructional language situations.

At the outset there was a fourth purpose that was, in the end, not realized in the study, but that I will describe here briefly as it influenced the research design. I planned to investigate whether expository instruction followed by other activities promoting learning through a variety of modalities and types of student involvement and communicative interaction would facilitate more learning than expository instruction alone. Thus, instruction was planned so that students heard an expository lesson, then completed a measure of learning outcome, then participated in a number of other learning activities related to the same content area as presented in the lesson, then completed another measure of learning outcome.

In the the previous chapter, issues surrounding whether to design convergent studies were discussed, and the linguistic bases of classroom instruction were explored. This chapter extends the literature review to focus more specifically on the conceptual and empirical underpinnings of the specific variables examined in this study. In particular, the use of an attention measure to indicate engagement in listening to a lesson is discussed and literature on attention is reviewed.

Model of Teaching and Learning

One way to conceptualize teaching and learning is as a series of interactions between people which involve sharing meaning. Communication can also be seen as a series of interactions between people which involve sharing meaning, and teaching and learning interactions as a subset of these. Teaching and learning interactions have a didactic goal: as an outcome of the interchange the learner will acquire or construct new understandings or knowledge (DeStephano, Pepinsky, & Sanders, 1982). Thus, particular kinds of meanings will tend to be shared. The roles of teacher and learner are differentiated, although not fixed: a person can be a learner at one time, and a teacher at another, or even both simultaneously. The knowledge that each participant brings to the interaction is important as it constrains what kinds of meanings can be shared and what understandings will be constructed. Furthermore, as the series of interactions is dynamic (a process), rather than static, the meaning under negotiation, roles, specific purposes, and understandings are constantly changing. These aspects of instructional interactions, therefore, vary both across individuals and across time.

Within the process-product tradition, the complex ways in which prior knowledge and approaches to instruction interact to influence learning outcomes often have been studied using aptitude-treatment interaction (ATI) designs (Corno & Snow, 1986). The core idea of ATI research is that "individual performance in education will be a product of whatever mixture of predispositions the individual brings to that performance in interaction with the demands of the educational tasks and the instructional structure superimposed on those tasks" (Fuchs & Fuchs, 1990). In practice, predictions of individual students' performance as a function of aptitudes and instructional treatments still cannot be made with confidence after twenty years of research (Deno, 1990). Rather than abandoning ATI research, Speece (1990) calls for more precise specifications of "aptitude" and "treatment." She suggests the use of more complex multivariate models in which treatment is reconceptualized as two-way instructional mediation, and dynamic changes accruing from transactions between the student and environment (rather than just statistical main effects and interactions) are examined. In the following section, I bring together in a model these conceptions of the dynamic and interactive nature of classroom teaching and learning.

Description of the model

This dynamic and interactive view of classroom teaching and learning is represented as a model in Figure 1, and can be seen as nested within a conception of communicative interaction (as represented in the sociolinguistic tradition of classroom research). This model is also theoretically consistent with the process-product tradition of classroom research, as it broadens the focus from ongoing classroom processes to a consideration of both these and the learning outcomes of the instructional interaction. I also draw on an information processing model of knowledge and memory to explain how it is that particular understandings are constructed and stored as new knowledge.

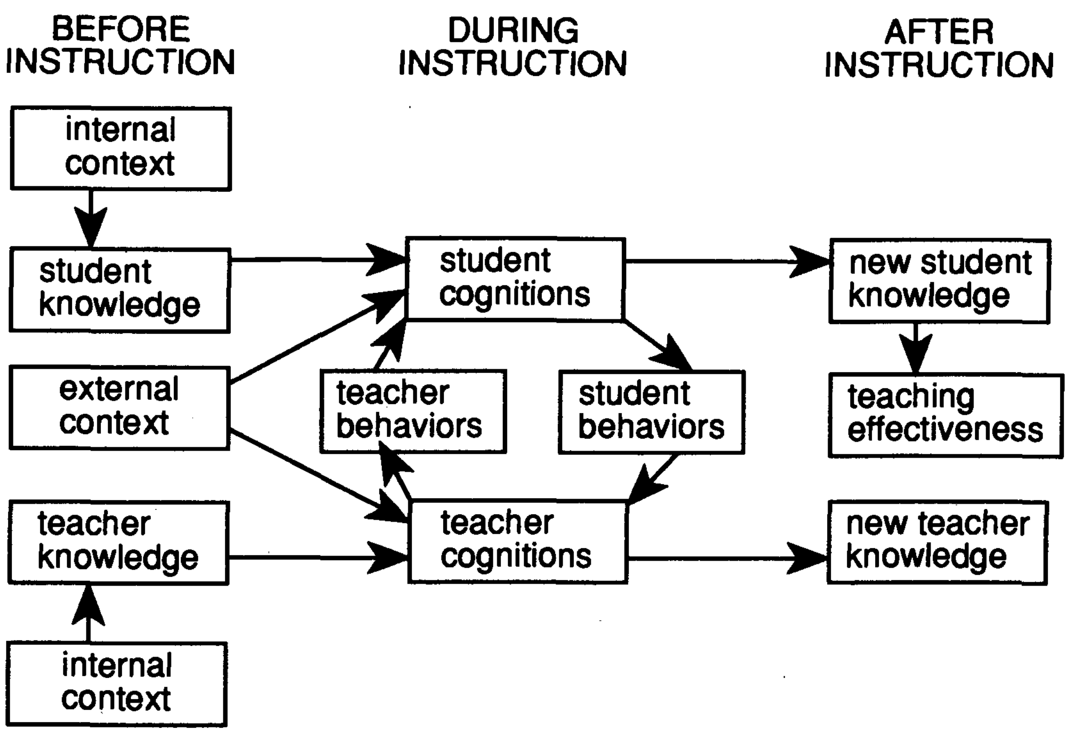

Figure 1. A dynamic and interactive model of classroom teaching and learning.

This model integrates the knowledge, cognitions, and behaviors of teachers and students before, during, and after instruction, represents the dynamic and interactive nature of these variables, and links them to predict student achievement, and thus student learning and teaching effectiveness. In using this general model to interpret particular instructional interactions, the context in which the particular teaching and learning occurs is of central concern (cf. Brinker's 1990, and Deno's 1990 discussions of the interplay between nomothetic and idiographic sciences). Contextual influences are many, and include both external objects and events (the location, the time of day, the materials at hand, and so forth) and the internal aspects of context (each participant's mood, expectations, recall of shared history, and so forth) (cf. Speece, 1990).

In describing this model, I begin by representing how a student learns from instruction, then I represent the instructional process for a teacher, and then I put these two strands together in an interactive model of teaching and learning over time and within context. The student's strand of the model can be described as follows. A student comes to an instructional situation with knowledge (e.g., declarative, procedural, and strategic knowledge, as described by Gagne, 1984), which can be partially represented externally as aptitude scores. During instruction, the student thinks, and these cognitions are partially represented externally as student behaviors or acts. At the end of the instruction, some changes to the student's knowledge have occurred, and these can be partially represented externally as achievement scores. Note also that these changes in knowledge are not necessarily of the sort that we conventionally think of as academic learning (for example, the student might have acquired some social knowledge, such as her teacher does not like the colour brown, or perhaps the student has discovered a new technique for pestering her seatmate without attracting the teacher's notice). The student knowledge that is the outcome of this instruction is what the student brings to the next learning situation.

In tracing this same process for the teacher, it is clear that a teacher comes to an instructional situation with declarative, procedural and strategic knowledge, which could be (but in research seldom is) partially represented externally with indices of teaching aptitude or other measures (see, however, Leinhardt & Greeno, 1986; Winne & Marx, 1977). During instruction, the teacher thinks and acts. The thoughts or cognitions are partially represented externally in the teacher acts or behaviors. At the end of instruction, changes have occurred in the teacher's knowledge, and these could be (but seldom are) measured. This learning outcome for the teacher is the new knowledge that can be applied in the next instructional experience. Except in training novice teachers, and recently, in studies of teachers' thoughts during instructional planning (Clark & Peterson, 1986), teachers' learning within specific instructional events (as contrasted with more general reflections on processes of teacher development) have seldom been focuses of study. Teachers' acts, as well, have more often been considered in the context of how these behaviors affect student learning, rather than for their relationship to teacher learning.

As teaching and learning are dynamic, thoughts and acts of teachers and students both prior to and following the instructional situation can also influence the ultimate learning of each participant. In this model, prior influences are captured in the initial measures of prior knowledge (teacher planning, for example, is represented as prior knowledge), and internal and external contextual influences. Subsequent effects are accounted for by the recursive nature of the models.

When the teacher and student processes are combined, the model becomes interactive as shown in Figure 1. The instructional situation is a sequence of teacher-student interactions. Each teacher act is an antecedent to subsequent student thoughts and acts, as are student acts antecedent to teacher thoughts and acts. In addition to providing self-feedback, each student act also provides feedback to the preceding teacher thoughts and acts, and vice versa. In this way, the instruction proceeds over time, with the teacher and student acts providing the substance and immediate context of instruction.

As noted earlier, the interactions and outcomes depicted in this model occur within a larger context, aspects of which impact on every element depicted in the model, and potentially at every moment. Examples include class heterogeneity with respect to ability levels, cultural background, or English language proficiency; classroom organization variables such as multidimensionality or methods of grouping for instruction; subject area of instruction; and so forth. It goes without saying that, as this is a model, it simplifies the teaching-learning events of real life. For example, in real classrooms, there are many students rather than just one, so the teacher is at the hub of many interactions, and there are other simultaneous student-student interactions (Cazden, 1986; Merritt, 1982). These are represented simply as "context" in this model.

<u>This study</u>

In this study, I traced a particular language-learning link to test a part of this larger model. I hypothesized that students' language knowledge, and pace and redundancy of instructional language, would interact to explain students' engagement in listening to an expository lesson, and their subsequent achievement on measures of lesson content.

In the remainder of this chapter, I present a rationale for why I selected particular elements of the teaching and learning model for causal modelling. In characterizing what learners and teachers bring to each instructional event, I focus on aspects of learners' language knowledge and of teachers' language use. In discussing processes during instruction, I review the empirical literature on attentional processes, and explain why I hypothesized this process variable would have an important causal role in students' comprehension of instruction and subsequent learning. The notion of learning outcome is briefly discussed. The theorized causal model is introduced, and specific research questions are posed.

What Teachers and Learners Bring to the Task

Both teachers and students bring many kinds of knowledge, including world knowledge, schematic knowledge, strategic knowledge, syntactic knowledge, knowledge of discourse rules, and so on, to any instructional task (Kamhi & Catts, 1989a). In this study, I have focused on a subset of students' language knowledge and two specific features of teachers' language use. As Roth and Spekman (1989) point out, "discourse is the primary linguistic medium through which academic information is imparted and acquired" (p. 176). Glover, Ronning, and Bruning (1990) also comment on the central role of language as a means of academic learning, and, in addition, note the acquisition of language knowledge and skills is also an important objective, or end of schooling:

> Reading is one major route to learning in school. The oral discourse of the classroom - classroom talk - is the other. Achievement of many educational goals depends on the content of classroom talk, its sequencing, and how the exchanges between teachers and students support instruction. Classroom discourse is the vehicle by which teachers guide, organize, and direct their pupils' activities. Classrooms are environments of communication.
>
> Classroom discourse serves at least two major aims of education. The first is the development of shared understanding .... A second desired outcome of classroom discourse is student competence in communication (p. 204).

Language is an end in that much of the curriculum, especially in elementary school, has the goal of teaching children receptive and expressive oral and written language skills, both explicitly, and as part of the implicit or hidden curriculum. Thus language learning is often an end of instruction, and this can be traced through the teaching-learning model just described. The focus in this study, however, is on the role of language as a means of teaching and learning academic knowledge.

A teacher uses language to teach academic content by talking and listening and talking again, and by selecting written instructional materials for students to read. Teaching often involves students in experiential learning, and demonstrating concepts or procedures using concrete materials or pictured representations. Here again, language plays a central role. Teachers can help students interpret what they experience or see by talking (e.g., stating the definition of a "polygon") or writing (e.g., writing a mathematical equation to represent the relationship between two sets of sticks). Teachers can use language to guide students to talk about what they experience or see, or to represent their understandings in writing.

Students learn by listening, talking, and listening again. The language skills of reading and writing are also tools of students' learning, particularly once they become competent users of written language. Students also learn by watching and doing, and this experiential learning is particularly powerful as they learn to represent their understandings linguistically, by talking and writing.

Language Ability or English Language Proficiency

It is clear, therefore, that language is linked to students' learning. A student's receptive language knowledge (ability to understand what is said and read) and expressive language knowledge (ability to produce spoken and written language) will influence how that student understands, participates in, and learns from the participant interactions that comprise instruction (Roth & Spekman, 1989).

The teacher's knowledge will influence how he or she talks while teaching, and thereby shapes the medium of instruction. The ways a teacher talks interact with the language knowledge a student brings to learning, to influence the teaching and learning outcomes. In order to learn in school, young students need to understand what the teacher says, and in order to teach effectively, teachers need to talk so that their students can understand. If students fail to have sufficient linguistic knowledge to understand (including pragmatic knowledge of classroom discourse), or if teachers fail to adjust their instructional language, the instructional language might be too complex to promote learning for these students.

Another side of this expression-reception model of communication is that students need to provide feedback to teachers about what they are thinking as the teacher teaches, and talking is one important way to do this; written products are another. The teacher needs to interpret this feedback in order to understand how to adjust his or her instruction, including use of instructional language. This expression-reception model of communication (Bloom & Lahey, 1978; Nelson, 1984) is integral to the teaching-learning model.

In this study, I have focused on one strand of this expressive-receptive interaction. I trace how students' receptive language ability for listening tasks interacts with aspects of an instructor's language to explain what students learn from listening to a verbally presented expository lesson. For students who speak English as a second language, proficiency at English language receptive listening, rather than their global language ability, is examined.

In making this argument about the importance of language for learning, I must point out that language knowledge, in all its complexity, is not the only important aspect of students' knowledge that will influence learning. In cognitive research on learning, for example, there is ample theoretical and empirical evidence that prior knowledge of the subject area is an important predictor of learning (See Mayer, 1987, for a review). Similarly, research on motivation shows that because of prior learning experiences and internal motivational constructs, students can be more or less motivated to engage in learning or in particular learning activities (Stipek, 1988). As researchers can not include every variable in every study, I intended to limit the influence of prior knowledge by teaching very young students about a forest animal that they knew of (so the instruction would be meaningful), but to present facts and concepts sufficiently complex and novel to be most likely unfamiliar to the children. Similarly, I worked with young students to mitigate the influences of achievement attributions (Stipek, 1988), and was careful in how I structured and explained the instructional tasks.

Instructional Language

There are several ways in which teachers can vary their instructional language in an expository lesson to increase or reduce the complexity of the listening comprehension task (or information processing task) for students. Teachers can use more or less complex vocabulary, syntax, or morphology. They can state central themes and relationships explicitly, or leave them to be inferred by their listeners. They can pose higher order questions or simple factual questions (Winne, 1979). They can use highly concrete, imaginal examples, or abstract verbal elaborations (Lapadat & Martin, 1992; Martin, in press; Paivio, 1986). They might or might not choose to use advance organizers, and to signal topic transitions (Mayer, 1987). Main ideas can be presented once, or they can be presented redundantly. Teachers can mumble, use mazes, or vary the pace at which they speak (Brophy & Good, 1986; Smith & Land, 1981).

Following my model of teaching and learning, these instructional language variables, in interaction with students' language ability (knowledge), and familiarity with the topic, are hypothesized to influence how complex students find the listening task to be. Of course, it seems likely that as skilled teachers deliver expository instruction, they continually monitor their listeners for feedback about whether they understand, and make adjustments to their instructional language. My questions of interest were whether adjusting instructional language by talking slower or adding redundancies do, in fact, help students understand, and whether these language adjustments have different effects for students of differing receptive language ability or English language proficiency. In order to answer these questions, I planned to hold other instructional language variables constant by using a rehearsed lesson script, and to systematically vary pace and redundancy of instructional language. Variations due to automatic responses to student feedback were minimized by having the students hold their questions and comments until the end of the brief lesson, and by following the lesson script the same way each time.

Processes During Instruction

Linguistic Complexity and Information Processing

Of the possible aspects of instructional language that could have been investigated, I chose to test the effects of pace and redundancy because of the importance of their influence on information processing complexity as predicted by an information processing model of learning and memory. Studies have shown that short term (or working) memory is constrained both by capacity, as defined by the number of bits of information that can be "held in mind," and by length of time information can be retained (Calfee, 1981; Glover, Ronning, & Bruning, 1990; Klatzky, 1975; Mayer, 1987). Typically, researchers report that a piece of information that is not rehearsed or presented again will be lost from short term memory after approximately 18 seconds. Information that is not available in short term memory to be acted upon (that is, connected with other pieces of information also in short term memory) will not be transferred to long term memory. It will not be learned.

Reducing the pace of the flow of new information by talking slower during expository instruction reduces the number of "bits" of information that need to be held in short term memory at any one time, and so avoids overloading short term memory capacity. (On the other hand, talking too slow could result in bits being lost before all the necessary bits are available to be assembled for any particular idea.) Modifying presentation of information to make it more redundant is one way to counteract the retention constraint of short term memory. Presenting a key idea, then presenting it again after about 12-15 seconds, should double the length of time that piece of information is in short term memory, and thus available to be learned. Slower paced and redundant instructional language would, therefore, be predicted to produce the "easiest" listening task, while increasing pace or reducing redundancy would be predicted to make the listening task harder.

The point is, what makes language easier or harder for people to understand depends both on the characteristics of the message as expressed by the speaker, and the linguistic capabilities of the listener. Both teachers' delivery of information in an expository lesson, and students' processing of that information, involving construction and encoding of new knowledge into long term memory, take place dynamically during instruction. Students provide feedback to the teacher, and teachers adjust their language on the basis of the feedback. These dynamic and interactive processes depend on the knowledge and experience both teachers and students bring to the task.

Attention

During an expository lesson, students can be more or less engaged in the task of listening. From an information processing perspective, engagement in a listening task involves attending to the incoming information and acting upon it (processing it, or thinking about it) to understand it. To the extent that there is some change to the listener's cognitive structures in long term memory, learning occurs. In this study, I was particularly interested in the cognitive process of attention.

Historical issues in studying attention. The nature of attention and its importance for learning have long been recognized by psychologists and educators. In 1890, William James said:

> Every one knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things to deal effectively with others (p. 403).

James also had an insightful comment on the role of attention:

> Millions of items of the outward order are present to my senses which never properly enter into my experience. Why? Because they have no *interest* for me. *My experience is what I agree to attend to.* Only those items which I *notice* shape my mind--without selective interest, experience is an utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground--intelligible perspective, in a word (1890, p. 402).

Yet, historically, the notion of attention has proven to be a difficult and often unpopular construct for investigators. Connolly (1970), referring to research at the turn of the century, commented that "the very ubiquity of the concept [of attention], coupled with methodological inadequacies of the introspective approach, led to its demise as a central problem in psychology." In a review of work on attention during the sixties, Moray (1970) described a resurgence in research on attention following Broadbent's (1958) seminal work, Perception and Communication. This renewed interest stemmed from the utility of operationalizing attention within the then popular stimulus-response paradigm, the American military's funding of applied research into attention, and advances in technology, particularly the tape recorder, that made new kinds of research possible (Moray, 1970).

This active period of interest in attention was characterized by investigations in neuropsychology, neurophysiology, psychophysics, speech perception, and applied fields like audiology, artificial intelligence, and special education. Models of signal perception, selective attention, and visual and auditory discrimination were developed and experimentally tested. One important finding was that attention was not a unitary concept describing a single type of behavior, but, rather, that there were several broad categories of behaviors or meanings of attention (Moray, 1970).

In recent decades, these investigations inspired by behaviorism have been criticized as too mechanistic. Educators have queried the applicability of the laboratory definitions and findings to the events of real classrooms. Psychological and instructional theorists have turned to cognitive mediational paradigms. As the relationships between learners' internal cognitive processes and their behaviors have been elaborated, and as researchers have come to believe that behaviors can be best interpreted grounded within context, researchers have extended their scope to study students within classrooms and other everyday settings. The popular current perspective of students as active learners who construct knowledge within a social context arises, in part, from a reaction against the overbearing emphasis of behaviorism on finding techniques for externally manipulating learners' behvavior. The perspectives on attention held by behavioral theorists (cf. Moray, 1970) are giving ground to more cognitive explanations.

A cognitive approach to attentional processes. Attentional processes have a key theoretical role in the information processing model of memory and learning that undergirds much current research on learning and instruction (Calfee, 1981; Glover, Ronning, & Bruning, 1990; Mayer, 1987). External stimuli impinge upon a learner, and only the information that is attended to has the potential to be learned. Rothkopf (1970), in his explication of mathemagenic activities as learners' behaviors that give birth to learning, outlined this issue. He used the statement, "You can lead a horse to water but the only water that gets into his stomach is what he drinks" (1970, p. 325), as a metaphor for how what is learned depends largely on the activities of the learner. He asked:

> What determines which capabilities a student has acquired after exposure to an instructional document? The content of the instructional material is undoubtably important. So is, to a lesser degree, its organization. But most important, to an overwhelming degree, is what the student *does with* the instructional document (Rothkopf, 1970, p. 326).

For Rothkopf, attentional processes that he labelled "set," "attention," and "orienting reflex" were included among the important things a learner did with instructionally presented material.

What learners attend to is a function of both their internal cognitive processes and resources, and the external characteristics of the stimulus. Learners direct their own attention based on their particular prior knowledge, abilities, motivations, and plans. External factors that have been found to draw attention include variation in the stimulus, affective imagery, discrepancy, incongruity, complexity, and ambiguity, as well as mands (verbal statements about what to pay attention to) (Gage & Berliner, 1979).

Sociolinguistic/ethnographic research has focused more on social correlates of attention, such as which students' discourse other students are more likely to attend to (Cooper, Marquis, & Ayers-Lopez, 1982; Wilkinson & Calculator, 1982), or how teachers distribute and direct attention (Merritt, 1982).

Rationale for investigating attention in this study. Attention is one predictor of learning outcome. In classrooms in which teachers teach by talking, either a lot or a little, we can wonder to what extent students attend to that talk, and what characteristics of the teachers' talk elicit greater attention. These questions were posed in this study.

Furthermore, I expected attention to function as a mediator between the variables of students' language ability or English language proficiency and characteristics of teachers' talk on the one hand, and students' outcome performance on the other hand. This is because the language aptitude students bring to a learning situation, as well as characteristics of the teachers' talk during presentation of a lesson, ought to influence whether students attend to a lesson, if my hypothesis about the interactive nature of information processing (and linguistic) complexity is supported.

Consider an instructional situation in which the instructional language is well matched to a learner's linguistic capabilities. All things being equal (motivation level, interest level of the topic, noise level in the classroom, etc.), assuming that students are predisposed to attend to instruction, and given that novel information is presented, I would expect that a student who had no difficulty understanding the lesson would be likely to attend to it. (Of course, if the student perceived the lesson as being extremely easy he or she might attend less than if it was perceived to be somewhat, but not excessively, challenging.) On the other hand, if the teacher's language is too complex for the student to understand, that student might make a brief effort to attend particularly carefully, and then, observing that understanding is not achieved, turn attention elsewhere.

I suggest, therefore, that language aptitude and the teacher talk variables in part explain students' attention to a lesson, and that all of these three variables in part explain students' outcome performance on a subsequent task keyed to the lesson content. This model does not specify, however, exactly what perceptual and thinking processes comprise "attention" and how one ought to measure it.

Overview of recent empirical research on attention. Several themes can be identified in recent research on the relationships between instructional presentation, complexity or difficulty, attention, and comprehension or learning. These include: studies examining whether predisposition to pay attention is a predictor of children's learning difficulties in general; studies investigating whether and what aspects of instructional presentation predict levels of attention on the part of young learners; studies examining more complicated links between instructional presentation, complexity of the content, attention, and learning outcome; and, finally studies concerning methodological issues tracking attention. Many of these studies have employed televised material, both because of the greater possibility of researcher control over the form and content of the lesson, and also, I suspect, because of the interest of producers of television programs for young children in finding out what characteristics of such programs will best capture their young audience's attention.

Attention as a predictor of achievement or learning disabilities. A number of studies have focused on whether disposition to pay attention predicts subsequent learning disabilities, or whether attentional levels can be used as a diagnostic indicator for identifying students with learning disabilities. Kuehne (1985), in her doctoral dissertation, reviewed research on sustained attention, defined as "the ability of the individual to maintain attention over time" (p. 7), selective attention, defined as "the individual's ability to focus on a stimulus while ignoring extraneous stimuli" (p. 7), and impulsivity. She concluded that "problems with selective attention, sustained attention, and impulsivity have been consistently noted in both hyperactive and learning disabled children" (p. 38). Kuehne administered a number of clinical measures of attention to children with attention deficit disorder (ADD), specific learning disabilities (SLD), or no known disabilies and found that "ADD children demonstrate more attentional problems than SLD and normal children and that SLD children demonstrate more attentional problems than normal children" (1985, p. 74).

Richman (1986) measured first grade students' off-task looking time ("sustained attention") and number of fixations off-task ("impulse control") during a 9.5 minute sustained attention laboratory task. He correlated these attention scores with teacher ratings of classroom behaviors indicative of learning disabilities and with correct detections of target visual items. He found a "significant relationship between sustained visual attention, impulse control, and teachers' observations of classroom behavior" (1986, p. 24). The amount of time the student spent looking off-task and the number of off-task fixations were both strongly negatively correlated with number of correct detections. He suggested these results were consistent with "the attentional-impulsivity deficit hypothesis" (p. 24).

Sinclair, Guthrie, and Forness (1984) examined "the link between severity of learning disabilities and severity of attention problems in ongoing classroom situations" (p. 18) of 28 children in classrooms for the educationally handicapped. They defined attending as "task-oriented verbal or gestural response" (p. 19) and non-attending as "eyecontact not directed to teacher, task material, peer who is reciting and/or other behavior incompatible with on-task activities" (p. 19). They found "a small but statistically significant relationship between the severity of children's attention deficits, as observed in ongoing classroom situations, and the severity of their learning problems" (p. 20). They noted that neither intellectual nor instructional variables (which they did not specify) accounted for this relationship.

Goldstein (1987) reported a longitudinal study in which the cognitive performance of approximately 2500 12 to 17 year-old adolescents was related to low attentiveness, hyperactivity, and aggressiveness measured earlier at ages 6 to 11 years. He found that students previously identified as "low attentive" were significantly behind the comparison group two to five years later on standardized measures of intellectual development and school achievement, even with adjustments for initial cognitive levels. He commented that this finding "points to the continuing impact of attentional problems on development into the adolescent years, an effect that goes beyond any initial disparity in cognitive development" (Goldstein, 1987, p. 220).

Two studies investigating the relationship between attention and achievement in samples of "normal" children found found a similar relationship between attention and achievement. Mevarech (1985) found that for grade two and grade four students, Task Oriented Behavioral Style, defined as "the pupils' ability to persist on tasks until completion, to adapt easily to new situations, to be sensitive to changes and not to be distracted" (p. 158), was highly predictive of mathematics achievement, especially for grade two students. Palisin (1986) had 50 mothers rate the temperment of their four-year-olds. A standardized intelligence test was also administered, Subsequently, when the children were in grade two, another intelligence test and a school achievement test were administered. Palisin found that the temperment ratings for Attention-Span and Persistence were significantly correlated with both of the intelligence measures and with the achievement measure. She noted that "the implications are that a child's ability to attend to tasks and modulate behavior may be the best predictor of performance on achievement tests" (Palisin, 1986, p. 766).

Instructional presentation as a predictor of attention. Beginning in the mid-seventies, Daniel Anderson and colleagues conducted a series of studies investigating young children's attention to television programs. Empirical investigations of the links between instructional presentation and attention are, for the most part, limited to studies of television program-watching. Lorch, Anderson, and Levin (1979) investigated the effect of two levels of visual attention to a television program on subsequent measures of content comprehension of two groups of five-year-olds and found no significant between-group differences. As they found significant within-group correlations between attention and comprehension, however, they postulated that "variations in the comprehensibility of the TV program may determine variations in children's attention to TV" (Lorch, Anderson, & Levin, 1979, p. 722).

In a subsequent study, Anderson, Lorch, Field, and Sanders (1981) investigated the effects of television program comprehensibility on preschoolers' visual attention to the television. Making the assumption that "attention is a necessary prerequisite to understanding and retention" (Anderson et al., 1981, p. 151), they undertook to investigate one possible determinant of attention. They manipulated verbal comprehensibility by inserting segments of foreign dialogue and backward dialogue into the program, and found this resulted in significantly lower visual attention for 2, 3-6, and 5 year-old children. They concluded that "a major determinant of young children's visual attention to a television program is the degree to which they are able to comprehend it" (p. 156).

Pingree (1986) replicated the Anderson et al. (1981) study with 3-6, 5, and 6-6 year-olds, but, in addition, obtained self-reports from the children on which segments they thought the most about and which they found hardest to understand. Her findings were consistent with the earlier Anderson et al. (1981) study. In addition, the children reported that the altered segments were harder to understand than the normal segments.

Tamborini and Zillmann (1985) produced six versions of a televised children's story in which they systematically crossed three approaches to inserting questions (curiosity-arousing questions inserted, personalized questions inserted, or statements rather than questions inserted) with two levels of pausing (pause inserted after pertinent information, or no pause inserted), and then measured kindergarten and grade one students' visual attention, information acquisition, and affective reactions. With respect to attention outcomes, they found overall visual attention was about 84 percent, that provision of long pauses was correlated with inattentiveness in the statement condition, and that lowest overall levels of visual attention were obtained when personalized questions were used. However, learning was significantly greater in the personalized question condition even though attention was lowest.

Instructional presentation, complexity, attention, and learning. Several researchers have conducted studies consistent with my interactional hypothesis that instructional presentation might be mediated by content complexity or difficulty, and attention, to explain learning outcome. A number of studies of children's television viewing have examined these linkages. Calvert, Huston, Watkins, and Wright (1982) related kindergarten and grade 3 or 4 students' attention to the formal production features (like sound effects, child dialogue, and camera zooms) of a televised program to their comprehension of the content. They found that for both age groups, "selective attention and inattention to certain formal features predicted comprehension, especially of incidental content" (Calvert et al., 1982, p. 601).

In a subsequent study, Calvert and Gersh (1987) inserted sound effects into a television program to guide kindergarten and fifth grade students' selective attention to, and hence comprehension of, central content. As predicted, they found that sound effects increased children's selective attention to the television, especially for younger boys. The relationship between sound effects and comprehension, as measured by a multiple choice recognition test, was inconsistent, but sound effects (and higher attention) appeared related to greater inferential comprehension.

In another study of television viewing, Calvert, Huston, and Wright (1987) systematically varied verbal and visual characteristics of inserted "preplays" summarizing plot events. They then measured first to fourth grade children's visual attention to and comprehension of the program as a function of the inserted preplays. They found that visual attention and subsequent comprehension of visual content was greater for children who viewed the visual (rather than strictly verbal) preplays, and that children who saw preplays using inferential narration (rather than those with concrete narration) scored higher in comprehension of verbal program content. They suggest this finding supports the notion of modality specificity in information processing.

Campbell, Wright, and Huston (1987) varied formal production features (two levels) and difficulty level (three levels) of a televised presentation of nutrition facts to kindergarten students, while keeping the basic information constant. A child and adult version was produced for each of three levels of difficulty. "Easier versions were longer, more redundant, and used simpler language; difficult versions presented information more quickly with less redundancy and more abstract language" (Campbell et al., 1987, p. 311). They found that difficulty did not affect attention significantly, but was significantly negatively correlated with comprehension as measured by free and cued recall tasks. Children who saw child versions attended more and comprehended more than children who saw adult versions.

Pezdek and Hartman (1983), following Lorch, Anderson, and Levin (1979), examined "the relationship between children's attention and comprehension of auditory and visual information on television" (p. 1015). They found a small but significant correlation between mean percent visual attention and mean comprehension score with five-year-olds. They interpreted their pattern of results as suggesting that "although children may ordinarily semantically process auditory information primarily during periods of visual attention [as concluded by Lorch et al., 1979], they have alternative processing strategies available to them" (p. 1022).

In his doctoral dissertation, David Rolandelli (1985) investigated five- and seven-year-olds' visual and auditory attention to and comprehension of televised stories that were either narrated or not. He found that both visual attention and comprehension were significantly higher in the narrated condition than in the nonnarrated condition, while auditory attention did not vary by narration condition. He noted that "visual attention predicts auditory and inferential comprehension as well as visual comprehension in the narrated condition" (p. 78), and made the interpretation that "if a child is looking at the program, he or she is probably listening as well, thereby processing information in both modalities" (p. 78). He concurred with Anderson et al. (1981) and Lorch et al. (1979)

that "children will visually attend more to that which is comprehensible" (Rolandelli, 1985, p. 78).

George and Tomasello (1984/85) investigated the effects of mean length of utterance (MLU), a measure of grammatic complexity, in videotaped stories on preschoolers' attention and comprehension. They found that children with a high MLU in their own expressive language attended most to the long MLU stories, and "comprehended obvious content best at the Long Level, and comprehended subtle content best at the Medium Level; [whereas] the low [MLU] group attended most at the Medium Level and comprehended little" (p. 115). They interpreted this as showing that complexity of the input language (the language in the videotape) and children's individual levels of linguistic development interactively explain children's attention and comprehension.

One final study that I will report here investigated the relationship between interest, attention, and learning. Unlike the above studies, Shirey and Reynolds (1988) measured attention and comprehension of adults doing a laboratory reading task, rather than that of children viewing television. They reported that "although interesting sentences were learned much better, less attention was allocated to them; hence attention did not serve as a causal mediator between interest and learning" (p. 159).

Summary of empirical findings. On the whole, the above studies indicate that there are consistent, statistically reliable relationships between presentation, complexity, attention, and comprehension. These relationships are complex and interactive, however. Interestingly, it seems that while characteristics of presentation, level of complexity, and amount of attention predict comprehension, children in these studies did not always attend most to the presentations with complexity best matched to their level of development. These studies also report a consistent finding that students who are least able to attend selectively, sustain attention, and inhibit impulsivity, are most likely to be identified as having learning disabilities, and to exhibit poor comprehension of content.

However, of the above studies investigating the relationship between presentation, complexity, attention, and comprehension, none used live instructors. Form and content of the televised materials included noninstructional animation, instructional animation, instructional exposition, commercial educational children's programs, and narrated stories. Several investigators did not use multivariate statistics to investigate the relationships between these variables, and none used causal modelling. (However, Shirey and Reynolds, 1988, used causal modelling in their investigation of interest, attention, and comprehension.) In my study, I planned to deliver live instructional exposition, and to use causal modelling and multivariate analysis of covariance to examine these kinds of relationships.

Measuring attention. In most of the studies reported here, attention was defined as visual attention to (most often) a television, or to a teacher or task materials. Visual attention was usually measured by an observer who either simultaneously recorded duration of eye gaze at the television monitor, or did so later from videotapes of the TV viewers. In most studies, recordings were made with electronic keying devices that produced computer-readable data, or directly using a computer and customized coding program. Percent attention (cumulative duration of eye gaze at the TV out of total program time) was then calculated, in most studies (see Anderson et al., 1981; Calvert & Gersh, 1987; Calvert et al., 1982; Calvert et al., 1987; Campbell et al., 1987; George & Tomasello, 1984/85; Lorch et al., 1979; Pezdek & Hartman, 1983; Pingree, 1986; Richman, 1986; Rolandelli, 1985; and Tamborini & Zillmann, 1985). In contrast, Shirey and Reynolds (1988) obtained two measures of attention: a duration measure (sentence reading time) and a secondary task reaction time measure.

One obvious reason for measuring visual attention is that many of these studies involved television programs, and television is considered to be a highly visual medium. Another reason for using visual rather than auditory attention measures is that it is relatively straightforward to observe and record direction and duration of eye gaze, but there are no such straightforward ways to track auditory attention. Rolandelli (1985), in addition to measuring visual attention in the manner described above, also developed a method of tracking auditory attention. He caused the sound quality of his televised materials to become degraded at intervals. Children could restore normal sound quality by pressing a lever, and their latency in doing so yielded an indicator of auditory attention. This method, while ingenious, is limited in application, and in addition could negatively influence children's interest in and attention to the television.

Given that most researchers were interested in children's comprehension or learning of both verbal and visual information included in television programs or instruction, is visual attention an adequate proxy for auditory attention? The findings on this are mixed. For example, Lorch et al. (1979), Anderson et al. (1981), and Rolandelli (1985) suggested that (auditory) comprehensibility of content predicts visual (and auditory) attention. On the other hand, Calvert et al. (1987) argued for modality-specific processing. Pezdek and Hartman (1983), while suggesting that children might process most semantic information while visually attending, also concluded that they also have alternative strategies available, such as auditorally monitoring the TV while playing, and returning their visual attention to the TV for important (visual or verbal) segments.

Other evidence comes from psychoacoustic, speech perception, and audiologic research. These researchers have found that comprehension of speech is facilitated by speech reading (lip reading) the visual cues of the speaker's face, for normal-hearing listeners as well as hearing-impaired listeners, and that listeners do direct their eye gaze at speakers' faces, especially in challenging listening conditions (Erber, 1972). Thus, both auditory and visual information is processed in normal speech perception. Eye gaze, therefore, would seem to indicate a listener's attention to a speaker. Teachers and public speakers use this implicit knowledge about eye gaze as they scan their audience for signs of attention. The relationship between eye gaze and auditory attention might be particularly direct among young children for whom understanding spoken language is a challenging and engaging task in itself.

One other source of evidence comes from Groner and Groner's (1989) recent review of neurophysiological and psychological research on the relationship between attention (as a cognitive process) and eye movement control. They note that whether it is possible to shift attention and eye movements independently is an old question in psychology. After reviewing several laboratory studies that have used techniques like recording neural activity in monkeys, measuring saccadic eye movements, and measuring scanpaths, they concluded that while attention can shift without corresponding eye movement, eye movement is always accompanied by a shift in attention.

Despite these inconclusive theoretical issues, in this study I decided to measure duration of on-task visual attention in the manner described in the majority of studies reviewed above (Anderson et al., 1981; Calvert & Gersh, 1987; Calvert et al., 1982; Calvert et al., 1987; Campbell et al., 1987; George & Tomasello, 1984/85; Lorch et al., 1979; Pezdek & Hartman, 1983; Pingree, 1986; Richman, 1986; Rolandelli, 1985; and

Tamborini & Zillmann, 1985). That is, I planned to calculate percent of duration of eye gaze at the instructor (live, rather than televised in my study). One reason is that this has been the most commonly-used approach to measuring young children's attention during a receptive listening (and watching) activity. The other reason is that I lacked a practical and naturalistic alternative for measuring auditory attention.

After Instruction: What was Learned?

Immediately following the expository lesson, I planned to measure participants' retention of key concepts presented in the lesson using a multiple choice picture task. Pictures avoid dependence on written language skills, which I did not expect to be developed adequately in second grade students to permit a written multiple choice test. A picture task also did not penalize children with delayed expressive language development, as as an oral reporting of knowledge might. The kind of knowledge tested in a multiple choice task is both highly specific and highly constrained.

As a second outcome measure, following the picture task, a group discussion and a drawing activity, I planned to obtain a verbal recall measure. This would measure what the children knew following all of the instructional activities. Furthermore, this would be a broader, less constrained indicator, as children would be prompted to "tell all they knew." However, children with expressive language delays might not be as successful at indicating what they knew via verbal recall as compared with the picture task. Both outcome measures were expected to tap children's grasp of concepts presented in the preceding lesson. For the second outcome measure, these concepts would have been practiced in various learning activities as well.

The causal model

A causal model linking students' language ability/English language proficiency and two instructional language variables with student attention to an expository lesson, and all of these to students' subsequent performance on two criterion-referenced academic tasks was posited. I planned to conduct an exploratory path analysis using multiple regression (see Figure 2).

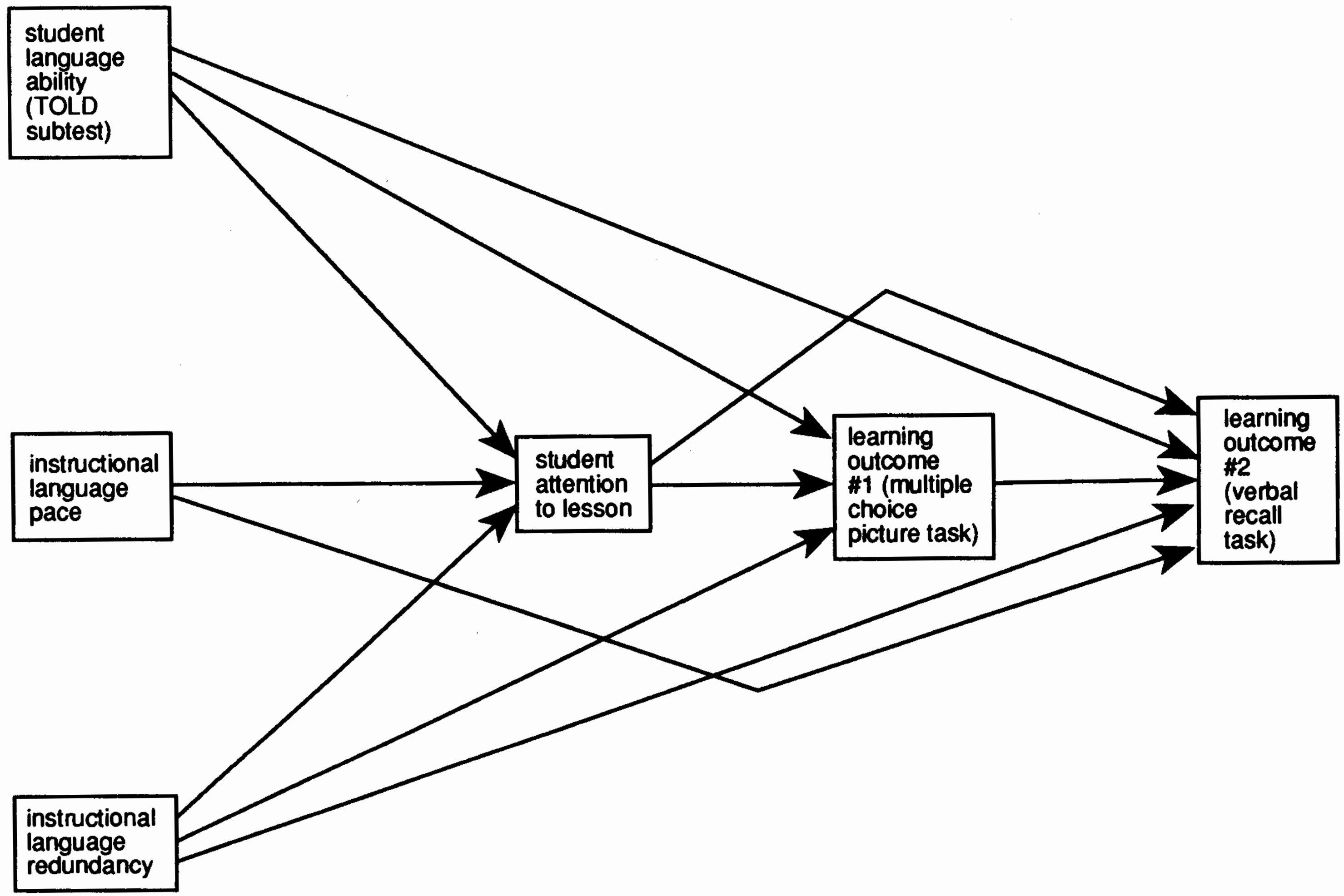

Figure 2. Hypothesized causal model.

Exogenous (predictor or independent) variables included a measure of students' language, and two levels of two instructional language variables--pace and redundancy. Endogenous (outcome or dependent) variables included a measure of students' attention during the presentation of a six to ten minute lesson on chipmunks and their habitat, and two measures of students' outcome performance on a subsequent tasks testing comprehension of concepts presented in the lesson.

Research Questions

1. Is the amount that students learn from a lesson, as measured by subsequent multiple choice and verbal recall tasks, related to their language ability/English language proficiency? (Is students' learning explained by their language ability?)
2. Does pace of presentation of a lesson predict learning outcome? How does this vary for students of different language abilities or learning needs?
3. Does redundancy of key ideas in a lesson predict learning outcome? How does this vary for students of different language abilities or learning needs?
4. How do these two instructional language variables (pace and redundancy) interact with respect to students' learning outcome, and how does this vary depending on language abilities or learning needs?
5. Does amount of attention students give to the lesson differ depending on language ability/English language proficiency, special needs status, pace or redundancy of the instructional language, or some combination of these?
6. Does amount of attention to the lesson make a difference to learning outcome, and does this vary depending on student language ability/English language proficiency or instructional language characteristics? In other words, does attention mediate between the predictors of language ability/English language proficiency and instructional language

characteristics on the one hand, and learning on the other? Are these relationships similar for those students with and those without special needs?

CHAPTER III

METHOD

Participants

Participants included 120 male and female students from thirteen year 3 (grade 2), combined year 2-3 (grade 1-2), and combined year 3-4 (grade 2-3) Primary Program classrooms from five schools in a large suburban school district in southern British Columbia. In addition, 42 other Primary Program students from four schools participated in preliminary pilot studies. In British Columbia, the ungraded, continuous progress Primary Program is described as encompassing years 1 to 4 rather than grades kindergarten to 3. Most students who participated in this study had a similar age range and level of study as "second grade" students elsewhere in North America, and will be described by grade rather than year in the remainder of this dissertation.

Participants ranged in age from 6 years, 4 months to 9 years, 11 months (6-4 to 9-11). Within each of the five schools, all grade 2, 1-2, and 2-3 classes of teachers who volunteered to participate in the study were included. All consenting grade 2 students were included, and additional subjects were randomly selected for inclusion from the pool of consenting grade 1 and 3 students to obtain a total of 24 participants within each of the five schools (see Table 1). Each student was randomly assigned to one of four experimental conditions, for a total of six students per group (condition) in each school, and a total of 30 students per condition overall.[1]

1One school, which I shall call "MOU," had insufficient volunteers to form four groups, thus 18 students participated in three groups. Another school, "CEN," contributed an extra fifth group which completed the condition missed at MOU.

Table 1

Number and Mean Age of Participants by School, Sex, and Grade

	Sex		
Grade	Boys	Girls	Total n
		CED	
1	1	1	2
2	7	8	15
3	3	4	7
Total	11 (8-2)	13 (8-2)	24 (8-2)
		CEN	
1	2	2	4
2	10	16	26
3	-	-	-
Total	12 (7-8)	18 (7-10)	30 (7-9)
		MOU	
1	-	-	-
2	8	10	18
3	-	-	-
Total	8 (8-0)	10 (8-0)	18 (8-0)
		ROY	
1	1	-	1
2	15	8	23
3	-	-	-
Total	16 (7-10)	8 (8-2)	24 (7-11)
		WES	
1	-	4	4
2	7	13	20
3	-	-	-
Total	7 (8-1)	17 (7-9)	24 (7-10)

Note. The 5 schools were code-named CED, CEN, MOU, ROY, and WES. Mean age is in brackets.

Design

Purposes of this study, as discussed in the preceding chapter, were to examine young students' learning in various instructional language conditions, and how learning processes and outcomes varied as a function of both instructional language and students' individual differences. Students' age, grade, sex, language ability/English language profiency (rated by their teachers and measured in a test of receptive vocabulary, as described below), and special learning needs (specifically identified by their teachers, as described below) constituted the individual difference data. The students were randomly assigned to one of four instructional language conditions (two levels of pace by two levels of redundancy). Working with the researcher in groups of six in a resource room in their school, the students listened to an expository lesson about chipmunks. During the lesson, students were videotaped so that their engagement, defined as visual attention to the instructor, could be determined. Students then independently completed a pictorial multiple-choice test of 12 key facts that had been presented in the lesson. They engaged in a small-group discussion about the content area, which was videotaped. Finally, students were individually interviewed by the experimenter. First, they talked about "everything" they knew about chipmunks (verbal protocol), and then they answered questions about the instructional tasks and instructional language (metapragmatic probe). These interviews were audiotaped.

The variables used in testing the causal model postulated earlier included three exogenous variables: students' language ability/English language proficiency, and the two instructional language variables, pace and redundancy (see Figure 2). Endogenous variables included attention, picture-prompted recall, and free verbal recall.

As well as the test of causal relationships, a multivariate comparison of means was conducted. In that analysis, the instructional language conditions created by varying pace and redundancy were construed as the independent variables, the language ability measure was a covariate, and the attention measure, the picture task measure, and the verbal protocol were multiple dependent variables (see Results chapter for further elaboration).

Not all of the data collected were used in the quantitative analyses. Some of this information was used informally and qualitatively in interpreting the quantitative analyses. In addition, qualitative case profiles were developed for four selected participants. The researcher examined and interpreted these students' scores, transcripts, videotaped records, and audiotapes, as well as information provided by teachers and contextual notes kept by the researcher, in a case study format.

Pilot studies

Pilot testing involved students in four Primary Program classrooms volunteering from the same and a neighbouring school district. The purposes of pilot testing were threefold: instrument development, development of data collection procedures (including development of instructional materials -- the chipmunk lesssons), and assessment of students' prior knowledge about the content area. Methods of scoring the picture tasks, and coding the videotaped attention data and the audiotaped individual interviews were also considered during the pilot phase, but these will be discussed in a subsequent section on data coding and scoring.

Instrument Development

Two instruments were developed for this study: a teacher interview questionnaire and a multiple-choice picture task. As well, the procedure for administering the receptive vocabulary test used for language assessment was modified and piloted.

Teacher interview questionnaire. For the teacher interview questionnaire, I designed a checklist and short answer form that requested background information about students, and could be filled out by teachers in no more than five minutes (see Appendix A). The form was discussed with and filled out by teachers in a pilot school during the development process.

On the teacher interview questionnaires, teachers indicated grade level of their class (grade 2 or combined 1-2 or 2-3). They recorded each student's birthdate and grade level, rated each student's language ability as low, average, or high, and indicated whether the student had special needs.[2] They were asked to check all of the following special learning needs that applied: English as a second language (ESL), learning disability (LD), behavior disorder (BD), mental handicap (MH), speech and/or language disorder (SP/LG), or other (OTH). If they indicated "other," they were asked to specify the student's special need (hearing impairment, giftedness, and so forth).[3] A space for more detailed comments about the students' learning was provided, but it was not used by any of the teachers. The teachers' identifications of special needs students and their ratings of students' language ability provided a validity check for standardized language test scores, and aided comparability with previous studies of particular special needs groups.

Multiple-choice picture task. Developing the multiple-choice picture task involved many steps. Twelve key facts that were both picturable and important were selected from the chipmunk lesson. A test item with five alternatives was developed for each key fact.

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[2]They were also requested to record the following two scores from students' most recent Canadian Test of Basic Skills (CTBS): the Listening Test raw score, and the Language Total raw score. However, MOU was the only school that had administered this standardized test, thus there was insufficient information for statistical analysis and the scores were not used.

[3]Note that teachers were asked to mark specific categories of special need if it was their impression that a student had that or those special learning needs. As the reliability and validity of the teachers' judgments cannot be ascertained, caution must be used in comparing these designations with the same labels used in other contexts, such as by school districts, or by other researchers. The advantage of relying on teachers' impressions is that I was able to consider possible special learning needs of many young students who might not yet have been formally identified as having special needs.

Four incorrect alternatives were generated by considering prior misconceptions that might be held by children this age (for example, mother chipmunks, like mother cats, might carry their babies by the loose skin of their necks), and misconceptions that might arise from incomplete comprehension of the lesson (for example, because two separate ideas presented were that chipmunks are good swimmers, and that chipmunks try to get away from their predators, students could incorrectly link these two ideas and assume that whenever chipmunks are in danger, they swim away). A group of children was interviewed about their knowledge and beliefs about chipmunks to assist in developing a pool of plausible incorrect alternatives.

Then the pictures representing each alternative in each multiple-choice item were drawn and the test booklet designed and compiled. Students were interviewed about each picture in the booklet to determine if they perceived the pictures as representing what was intended and whether they judged the targets and alternatives as plausible. The test booklet was then revised accordingly.

Initially, I intended students to circle letters corresponding to their answers on a separate answer sheet, but pilot administations proved this procedure too confusing. Each student, therefore, received his or her own picture booklet. For each of the twelve items, students selected one picture and circled the letter above it to indicate the answer. A practice item was developed for teaching the answering procedure, and a script for the instructions for doing the picture task was also developed. Following further trials and reliability analyses (described in Appendix B), the script (in Appendix C) and the picture task instrument (in Appendix D) were adopted for the study.

Language assessment. The receptive vocabulary subtest of the *Test Of Language Development* (*TOLD*) was adapted for small group administration for this study, and pilot tested. In standard administration, a child who is being individually tested looks at a plate of three pictures labelled A, B, and C. When the clinician says the vocabulary item, the child points to the corresponding picture. This is repeated for the 25 items. There are training items, and provision for ending the test early if a ceiling is reached.

The test was adapted to enable simultaneous administration to groups of six students. Three students looked at a picture booklet together. Rather than pointing at a picture to indicate their answers, each student printed A, B, or C beside the item number on an answer sheet. Training items were practiced until each student was comfortable with the procedure. Students were instructed not to talk or point during this activity, and to keep their answers secret. All 25 items were administered, and students who missed recording answers for items were later individually readministered those items. In all other ways, the test was administered using standard protocol.

Tests of receptive vocabulary are commonly used as a first approximation of language ability, and the modified *TOLD* was used for this purpose in this study. There are several cautions to keep in mind, however. Language ability, rooted in communicative context, is a complex construct that cannot be adequately measured by a single standardized test, or even a battery of standardized tests. For example, as McLean and Snyder-McLean (1978) point out, the processes underlying receptive language and expressive language are qualitatively different, and "consequently, we should not infer that the child's development in one is a direct index of his development in the other" (p. 84). And Muma argues that tests of receptive vocabulary only measure one aspect of receptive language ability, "the comprehension of labels" (1978, p.147). Finally, for those students learning to speak English as a second language (ESL), any measure of English language comprehension or production cannot be considered a measure of language ability, but only indicates English language proficiency.

On the other hand, batteries of tests used to measure language ability or English language proficiency usually demonstrate high intercorrelations among the component tests (Hisama, 1980). This is why researchers and clinicians choose to use receptive vocabulary scores as a provisional indicator of language ability/English language proficiency when time is limited, and when a general language indicator rather than detailed diagnostic information about patterns of knowledge and skills is needed. In this study, the use of the *TOLD* can be further justified in that receptive language (listening) ability was of primary relevance, and also the *TOLD* scores were reliably correlated with teachers' judgments of their students' language levels ($r = .42$). For the ESL students, the intent was not to determine their language ability, but rather to estimate their functional proficiency at understanding spoken English vocabulary.

Development of Instructional and Data Collection Procedures

The chipmunk lessons were developed prior to beginning the study. Pilot sessions with students were used to practice and revise instructional and data collection procedures in the chipmunk lessons. These materials and procedures included scripts for giving instructions about tasks, the chipmunk lessons, and delivering the four instructional language conditions within the lessons. Protocols were developed for videotaping the students' attention during the lesson and their participation in group discussions, and conducting the individual interviews. Of these, only developing, presenting, and videotaping the chipmunk lesson required several phases of pilot study.

The chipmunk lesson. Content for a lesson about the life and habitat of chipmunks was adapted from two sources (*Audubon Nature Encyclopedia*, 1965; and Switzer, 1985). The final version of the chipmunk lesson was an expository presentation about chipmunks and their habitat that I delivered verbally from a memorized text with a script at hand to refer to as necessary. The language and concepts of the chipmunk lesson were designed to be moderately challenging for average grade 2 students, while still familiar in style and type of information presented. I presented this lesson either fast or slowly, and either redundantly or nonredundantly (see below). The text of the lesson was identical across the four conditions except that, in the two redundant conditions, each of the twelve key facts was repeated, whereas they were not in the two nonredundant conditions (see introduction script in Appendix E, and chipmunk lessons in Appendix F).

Pace and redundancy. According to Smith and Land (1981), teachers talk at an average rate of 130 words per minute (wpm). In this study, for the slow paced lessons, I spoke at a rate of 120 words per minute, and for the fast paced lessons, I spoke at a rate of 150 words per minute.[4]

In this study, redundancy was defined as the verbatim repetition of key ideas immediately after their first mention. The same vocabulary and sentence structure were used in the repetition in most cases; however, slight syntactic and morphological variations were allowed where necessary to retain the naturalness of the text (see lesson scripts in Appendix F). The redundant lessons included these repetitions, and the nonredundant lessons did not. This form of redundancy was used rather than partial repetition or repetition with rephrasing because, with either of these other types of redundancy, the form or the content of the information can change, thus one could argue

[4]The "fast" pace of speech seemed to me to be a comfortable conversational speaking rate, typical of what I use in casual conversation with adults or linguistically capable children. The "slow" rate, while seeming very slow, was nevertheless still within my usual range of speaking rates. I typically use this rate of speech when talking to young or language delayed children, or when instructing learners of any age in novel and difficult content.

that any effects of increasing redundancy are not due to the redundancy but rather to added content or emphasis in the repeated information.

For each of the twelve key ideas, the content necessary to correctly identify the target picture in the multiple-choice picture task was the information repeated in the redundant conditions. However, not all of the supportive contextual and elaborative content referring to that key idea was repeated; thus, the repeated portion did not contain all the information necessary to reject the incorrect alternatives.

The four versions of the lesson used in the study were as follows. In Condition 1, the instructional language was fast and nonredundant. In Condition 2, the instructional language was fast, but redundancies were added. In Condition 3, the instructional language was slow but nonredundant. In Condition 4, the instructional language was both slow and redundant. The lessons varied in length from six minutes in Condition 1 (fast and nonredundant) to 10 minutes in Condition 4 (slow and redundant).

During the pilot phase, I practiced delivering the four versions of the lesson in front of a video camera, and evaluated the delivery. I also delivered the lesson to helpful colleagues and to a group of children, who provided feedback. Once satisfied that the content, text, and length of the lesson was appropriate, and that my style and pace of delivery was consistent, I piloted the four conditions with several groups of children to refine the instructional and data collection procedures.

Attention

As discussed in the preceding chapter, attention was conceptualized as mediating between the students' language ability/proficiency, facets of instructional language, and the students' learning outcomes (as measured by the multiple-choice picture task and the verbal recall score calculated from the verbal protocol). The students' visual attention, defined as eye gaze at the instructor during delivery of the chipmunk lesson, was used as an indicator of their engagement in the learning task of listening. Students were videotaped while listening to the lesson, in order that direction of their eye gaze over time could be quantified subsequently (see sections on procedures and data coding).

Prior Content Knowledge

The multiple-choice picture task was administered to 31 students who had not participated in the chipmunk lesson. This provided an indicator of prior knowledge about chipmunks held by this grade level of students. Eighteen of these students then listened to the chipmunk lesson and were readministered the picture task, which provided information about whether other students at this grade level did, in fact, learn from the chipmunk lesson (see Appendix B). Qualitative information about students' knowledge of chipmunks was also gathered through discussions with groups of students described above.

Procedures

Once the approval of the University Ethics Committee at Simon Fraser University was obtained, and the school board and the five schools had agreed to participate, information and consent forms were distributed to teachers and families (see Appendix G). Following collection of the consent forms, classroom pilot testing was conducted, then schedules for data collection were established. I initiated this process in each school by meeting with the principal and interested teachers, and providing a brief verbal and written description of the study and data collection procedures. Information and consent forms to be distributed to students were given to those teachers who agreed to participate. A few days later, I returned to collect consent froms, set up a data collection schedule, and distribute teacher interview questionnaires.

Language Assessment

The language assessment was conducted in a separate visit within ten days of the chipmunk lesson using the modified small group version of the receptive vocabulary subtest of the *Test Of Language Development* (*TOLD*). For one mentally handicapped student who was unable to complete the test using the group format, I administered the test individually using the standard procedure; otherwise the group administration procedure described earlier was followed.

Introduction to Instructional Tasks

In each school, data were collected from each group (condition) in turn. The six students assigned to a condition (e.g. Condition 1, which involved fast, nonredundant instructional language) met with me in a resource room in the school.[5] The students sat on the floor facing me (I also sat on the floor). I introduced myself and discussed the purpose of the research with the students. I gave an overview of the activities in which they would be involved, talked about and let them them have a close look at the video camera, and answered questions. I told them to pretend that I was a world-famous chipmunk scientist who was going to tell them all about chipmunks, and to listen carefully, as later they would have turns being chipmunk scientists too. I then proceeded with the chipmunk lesson. The introduction and instructions followed a script (see Appendix E), as did the lesson (Appendix F) and all of the task instructions throughout the session. Each session lasted about an hour.

The Lesson and Instructional Language

Immediately prior to hearing the lesson, the students were shown two pictures of chipmunks from Switzer's (1985) children's nature book as part of the introduction to the

[5]The scheduling of sessions was varied so that data from each condition were collected in both morning and afternoon time slots across the five schools.

lesson topic. The two pictures selected did not visually display any of the twelve key ideas that were later tested in the multiple-choice picture task. Then the chipmunk lesson was delivered verbally without accompanying visual materials. Visual confounds were avoided to better assess the influence of variations in instructional language and students' individual differences in language ability (and/or English language proficiency) on students' attention to, comprehension of, and learning from verbal instruction. The students' task during the lesson was to listen. Questions and comments were responded to prior to or after, but not during the lesson.

While varying pace and redundancy, I made every effort to keep nonverbal and suprasegmental aspects of communication consistent across sessions and schools. For example, in each session I looked at the students in turn as I talked, and I tried to keep my voice equivalently cheerful and expressive, to speak loudly and clearly, to emphasize words in the same way, and to keep pauses proportionally equivalent.

Attention

The students were videotaped during the chipmunk lesson in order that a measure of attention could subsequently be calculated. While presenting the lesson on chipmunks, I sat on the floor directly in front of the group of six students, who were also seated on the floor facing me. A video camera located immediately behind, slightly above, and to the left of my head recorded the students' eye gaze at me, the instructor. My delivery of the lesson was recorded on the auditory channel of the videotape using a piezo-electric floor microphone. I used a remote control to start and stop the camera to reduce the distracting effects of the camera's presence.

Picture Task

Following the lesson, the multiple-choice picture task was administered (see Appendices C and D). The students moved to individual work areas in the resource room while two of the children handed out the picture booklets and pencils. Then the students were instructed to look at the practice item on the first page. They were told: "Find the picture of a chipmunk. Put a circle around the letter for the picture that looks most like a chipmunk." Students were given prompts about the answering procedure. Once everyone had responded, the answering procedure was modelled, the best answer was identified, and they were given a chance correct their answers. The test began once everyone understood the answering procedure. Instructions included encouragement to guess if they were not sure, and a reminder not to share their answers with anyone. The test was paced so that each child had time to select an answer for every question.

As described earlier, the multiple-choice picture task consisted of a practice item and twelve items, each corresponding to twelve key concepts in the lesson. All of the alternatives were presented as pictures of chipmunks and their habitat; no words appeared on the pages. Each item was introduced with a brief verbal cue, which was repeated twice. For example, the cue for the first item was: "Look at number 1. Where does a chipmunk live? Circle the letter." Following completion of the last item, the test booklets were collected.

Group Discussion

After completing the picture task, students again sat on the floor in front of the video camera. They were arranged in a semi-circle to facilitate group discussion and orient their faces to the camera. They were told that they would have an opportunity to talk about chipmunks with each other while I did some writing. If they had trouble initiating the discussion, I designated a student to begin by telling everyone what chipmunks look like (see discussion group script in Appendix H). I then withdrew to a corner of the room and bent over some papers while the students talked with each other.

As they talked, I completed a topic checklist (see Appendix I) to record which of the twelve key ideas were mentioned, how many comments were made about each idea, and whether the comments were factually correct, incorrect, or neither. After approximately three minutes of discussion (or sooner, if discussion had broken down, or no new ideas were being expressed), I rejoined the group and prompted the students to talk about each of the key ideas that had not already been discussed spontaneously. I also encouraged any children who had not yet contributed to the discussion to take a turn telling the others something about chipmunks.

The group discussion was intended to provide an opportunity for students to extend their learning about chipmunks by telling each other what they knew, and by hearing peers talk about what they knew. It also provided an opportunity to consider again each of the twelve key facts (first presented in the expository lesson and then tested in the picture task). The group discussion was videotaped.

Individual Interviews

The students then gathered at a table,[6] drawing paper and markers were distributed, and the students were asked to draw a picture about chipmunks. This provided an opportunity for the students to represent their knowledge nonlinguistically. While the drawing activity proceeded, students were taken aside one at a time for individual interviews.

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[6]Two groups at CED school sat on the floor because we were working in a small area of the library that did not contain a table.

The individual interview had two parts (see Appendix J). First the student was told it was his or her turn to pretend to be a chipmunk scientist, and to tell me everything he or she knew about chipmunks. Each student was prompted to continue until nothing more could be recalled, or until no new information was forthcoming. This portion of the interview yielded the verbal protocol from which the verbal recall score was extracted. The verbal recall score provided a second outcome measure. It was a broader measure than the picture task in that it was not limited to the twelve key ideas, and it reflected expressive recall rather than picture-stimulated recognition. The verbal recall task also reflected students' knowledge after a variety of learning activities, as compared with the picture task, which measured learning outcome after the chipmunk lesson alone.

Second, each student was asked 8 questions to probe perceptions of the previously manipulated characteristics of instructional language. Each was also queried about his or her perception of the difficulty level of the lesson, how the chipmunk lesson could be improved, and what part of the day's activities was most enjoyable. I have labelled this second part of the individual interview the metapragmatic probe. Both parts of the individual interview were audiotaped on a portable Superscope cassette tape recorder with an internal microphone.

The students then returned to their classrooms, and the six students assigned to the next group (e.g., Condition 2) proceeded to the resource room. The procedure described above was the same for each of the four conditions.

Data Coding and Scoring

Language Assessment

The language test was scored according to the published instructions for scoring the receptive vocabulary subtest of the *Test Of Language Development*. Raw test score (number of items correct out of 25), rather than language quotient, was used in the analyses. This was because the students' variations in age (ages 6-4 to 9-11) and grade (grades 1-3), as well as the previously described adaptations to the administration procedure, would have made use of the standardized language quotients questionable. Furthermore, use of an absolute language ability/proficiency measure rather than one standardized by age was more appropriate for statistical analyses.

Attention

A duration measure of attention was calculated for each student as the proportion of time a student looked toward the instructor out of the total lesson time. The videotapes of the students listening to the chipmunk lessons were viewed and coded using computer software developed for this purpose.[7]

As the coder viewed the videotape, he or she observed one student for the duration of the lesson. The coder pressed keys on the computer keyboard to record shifts in direction of eye gaze. One key represented "attention on" (the student was looking at the instructor), one key represented "attention off" (the student was not looking at the instructor), and a third key was pressed to indicate "missing data" if a student moved out of the camera's field. When students moved behind another student so that their faces were not visible, they were coded as "attention off." Data were recorded by the computer program to an accuracy of one-tenth of a second.

In addition to coding shifts in direction of gaze, the coder simultaneously coded sentence boundaries. To aid this process, prior to coding I placed an auditory marker at each sentence boundary in the videotape of each lesson. (This marker was placed on the

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[7]The attention coding software was developed by Larry Wiebe at the Centre for Educational Technology at Simon Fraser University for the purposes of this study. The program runs on a MacIntosh computer and was written using Hypercard.

second, unrecorded auditory track, so as to leave the original recording on the first auditory track unaltered, and was audible when the two tracks were mixed.) Therefore, while coding gaze shifts, the coder heard a "clang" at the beginning of each sentence and pressed a key to code the sentence boundary. Keys were also pressed to initiate and stop the coding record and timer of the computer program.

The program recorded and calculated several kinds of information.[8] For each student and for each sentence in the lesson, I obtained a record of the length of the sentence in seconds; the time in seconds the student spent attending, not attending, or was out of camera range; and, the proportion of time attending out of each sentence's total time. The program also summed these data across the whole lesson and calculated absolute (in total seconds) and proportional (in percentage) scores of attention, inattention, and missing data for each student. The measure used in subsequent analyses was the cumulative "attention on" time divided by total lesson time less missing data time. Percent attention, rather than absolute duration of attention, was used to adjust for the different length, in minutes, of the four versions of the lesson.

I did the attention coding for all of the 120 students in turn. A colleague independently recoded 12 randomly selected students using the same coding protocol in order that coding reliability could be assessed. Coding reliability calculated on the cumulative "attention on" time proportion was found to be high, with $r = .94$.

Picture Task

The picture identification task was scored out of twelve for each student. Each correctly identified picture scored one.

[8] As each student's attention record was stored on a card in the hyperstack, each card could be readily viewed on the monitor or printed out.

Verbal Protocol

As described previously, the verbal protocols were the audiotaped data gathered from students in individual interviews conducted after they had participated in a series of learning activities. The first step in coding these data involved transcribing word-for-word what each the student said. Types of comments and prompts I made while interviewing were noted, but not transcribed (see the transcription codes in Appendix K).

The transcripts were then coded by underlining each true statement about chipmunks that had also been presented in the chipmunk lesson. Statements that were true but about topics that had not been discussed in the chipmunk lesson, vague or general statements that could be true of most animals, uninterpretable statements, and fantastical narrations were not underlined. Misconceptions, defined as untrue or nonfactual statements about chipmunks, were coded separately. Fantastical narrations about chipmunks were flagged, and neither coded as true or untrue. The total number of true statements about chipmunks was then tallied, and this score was the verbal protocol score for each student used in subsequent analyses (refer to coding protocol in Appendix L).

I coded all of the students' verbal protocol transcripts, and a colleague independently recoded 12 randomly selected transcripts. This yielded a count of 55 "hits" (statements we both identified as facts), 8 "misses" (statements I identified as facts but my colleague did not), and 1 "intrusion" (a statement my colleague identified as a fact but I did not). Percent agreement was 86%.

Other Data

Some of the data collected were not coded or scored for formal quantitative analysis. The group discussion videotapes and the audiotapes of the metapragmatic probe portion of the interview were not coded or scored for use in this study. The discussion group checklists and the students' artwork were also not formally analysed. The sentence-by-sentence attention scores were calculated but not analysed.

Qualitative Profiles

To supplement the quantitative analyses, and to portray individual differences of the students not retrievable from numerical data, I selected four students for more detailed qualitative profiling. They were selected on the basis of their *TOLD* scores (I wanted two who scored at the mean, one at minus 1.5 standard deviations, and one at plus 1.5 standard deviations). The other criteria were that each was assigned to a different instructional language condition, and that there were no missing data for any case. These selection criteria yielded 8 cases for possible analysis. Randy was the only case assigned to Condition 2 of the 8 students, so he was selected. Jonie (1 of 3 possible cases in Condition 3) was selected because she was the only girl out of the 8 cases. Of the remaining four cases, 3 were from the same school, so Geoffrey, who was from a different school, was selected for the Condition 1 profile. The two possible cases from Condition 4 were both ESL boys from the same school and the same group, so Mika was selected by flipping a coin. Thus, they were not chosen as exemplary or prototypical cases, but rather to give a snapshot of the individual differences of a chance set of students.

CHAPTER IV

RESULTS

The results of the study are discussed in five sections. The first section reports descriptive analyses, correlations and other preliminary examinations of the data, including some univariate statistics. In the second section, path analytic models of students' learning from instruction are presented. Third is a comparison of means, employing Multivariate Analysis of Covariance (MANCOVA). In the fourth section, qualitative case profiles of selected students are presented. The chapter closes with a summary of major findings.

Preliminary Descriptive, Correlational, and Univariate Analyses

Examination of the Six Main Variables

Of the information gathered that was quantified for analysis, six variables were used in the multivariate analyses involving, first, multiple regression analyses for causal modelling, and secondly, MANCOVA for comparison of means. Four of these variables were continuous, including *TOLD*, Attention, Picture Task, and Verbal Recall. The *Test of Language Development* (*TOLD*) receptive vocabulary subtest raw score was used as an indicator of prior language ability/English language proficiency. *TOLD* was an exogenous variable in the path analysis and a covariate in the MANCOVA.

The second main variable, Attention, was conceptualized as a process variable reflecting students' engagement as they listened to the chipmunk lesson. It was calculated as the percentage of time out of the total duration of the lesson that a student visually attended to the instructor. This mediating variable was analyzed as an endogenous variable in the path analysis and as the first outcome variable in the stepdown MANCOVA.

The third continous variable was the score on the multiple-choice Picture Task. The Picture Task was the first of two learning outcome variables, and was a measure of students' recall of twelve key facts immediately following listening to the chipmunk lesson.

The Picture Task was a second endogenous variable in the path analysis and a second outcome variable in the stepdown MANCOVA.

The Verbal Recall score was the other continuous variable used in the main analyses, and it represented the total number of facts about chipmunks expressed in the individual interview. Verbal Recall was the final outcome measure taken following all of the instructional activities. It was the final endogenous variable used in the path analysis, and the final outcome variable in the stepdown MANCOVA.

Instructional language was characterized by two factors, Pace and Redundancy, with two levels each. These two noncontinuous variables were crossed in a two by two design to create four instructional language conditions. In Condition 1, the instructional language was fast and nonredundant, in Condition 2 it was fast and redundant, in Condition 3 it was slow and nonredundant, and in Condition 4 it was slow and redundant. Pace and Redundancy were effects coded for multiple regression analysis (following Pedhazur, 1973), and constituted two exogenous variables in the path analysis. In the MANCOVA, they were the two independent variables (factors) representing treatment conditions.

Descriptive statistics calculated for *TOLD*, Attention, Picture Task, and Verbal Recall are shown in Table 2. Each of these variables was normally distributed, except that *TOLD* and Verbal Recall were mildly leptokurtic, and Verbal Recall was also moderately skewed in a positive direction. These descriptive statistics were calculated on 120 students, except for Verbal Recall, for which there were 10 missing data points.

Table 2
Mean Scores on Measures of Language Ability (*TOLD*), Attention to the Lesson, Multiple-Choice Picture Task, and Verbal Recall.

	Measure			
	TOLD[a]	Attention	Picture Task	Verbal Recall[b]
M	17.6	67.8	6.2	7.2
SD	3.0	16.2	2.3	5.5
Min	5	12	1	0
Max	23	98.5	12	26
Max Possible[c]	25	100	12	138[d]

Note. $N = 120$, except for VER, for which $N = 110$.
[a]Kurtosis = 1.56.
[b]Skewness = 1.22 and kurtosis = 1.53.
[c]While the maximum possible score varied, the minimum possible score for each measure was zero.
[d]Approximate count of facts in lesson.

Means and standard deviations for *TOLD*, Attention, Picture Task, and Verbal Recall were also examined by condition (see Table 3). Each cell included 30 students, except as noted below.

Table 3
Mean Scores and Standard Deviations for Language Ability (*TOLD*), Attention, Picture Task, and Verbal Recall, by Instructional Language Condition.

	Mean Score			
Condition	TOLD	Attention	Picture Task	Verbal Recall
1: Fast/ Nonredundant	17.6 (3.3)	70.1 (21.3)	5.3 (2.0)	6.0 (4.8)
2: Fast/ Redundant	18.1 (2.6)	73.8 (13.4)	6.7 (2.6)	7.8[a] (6.0)
3: Slow/ Nonredundant	17.6 (2.6)	66.4 (17.5)	6.8 (2.0)	7.8[a] (4.7)
4: Slow/ Redundant	17.1 (3.4)	60.9 (17.9)	6.1 (2.3)	7.3[b] (6.5)

Note. Standard deviation is in brackets (). The $n = 30$ per cell, except where noted.
[a]$n = 28$.
[b]$n = 24$.

A one-way analysis of variance (ANOVA) of *TOLD* by Condition did not detect statistically reliabledifferences, $F(3, 116) = 0.55, p = .64$. As students were randomly assigned to treatment conditions, I did not expect *TOLD* scores to vary by Condition. This result shows that students in the four randomly assigned conditions were equivalent in language level at the beginning of the study.

A two-way ANOVA of Attention by Pace and Redundancy showed a statistically reliable main effect for Pace, $F(1, 116) = 6.48, p \leq .01$, but neither the main effect for Redundancy nor the Pace by Redundancy interaction were statistically reliable. The pattern of mean Attention scores suggests that students attended to the instructor more when fast paced instructional language was used to deliver the lesson, and they attended less when slow paced instructional language was used. They paid the least attention when the instructional language was both slow and redundant. To examine this dichotomy, means for Attention by Pace were calculated. Mean Attention in fast paced instruction was 71.92 (*SD* = 17.75) and mean Attention in slow paced instruction was 63.66 (*SD* = 17.79). The Effect Size, calculated using Cohen's d-index with pooled standard deviation (Cooper, 1984; Lapadat, 1991; Rosenthal, 1984), was -0.46, showing that students, on average, paid less attention to the instructor by almost half a standard deviation when the instructor spoke slowly.

A two-way ANOVA of Picture Task by Pace and Redundancy showed no statistically reliable main effects for Pace or Redundancy, but the Pace by Redundancy interaction was statistically reliable, $F(1, 116) = 6.29, p \leq .01$. Students scored equivalently high on this multiple-choice task when they had heard a fast but redundant lesson or a nonredundant but slow lesson. Scores were lower in the slow and redundant condition, but lowest of all in the fast nonredundant condition (see Figure 3).

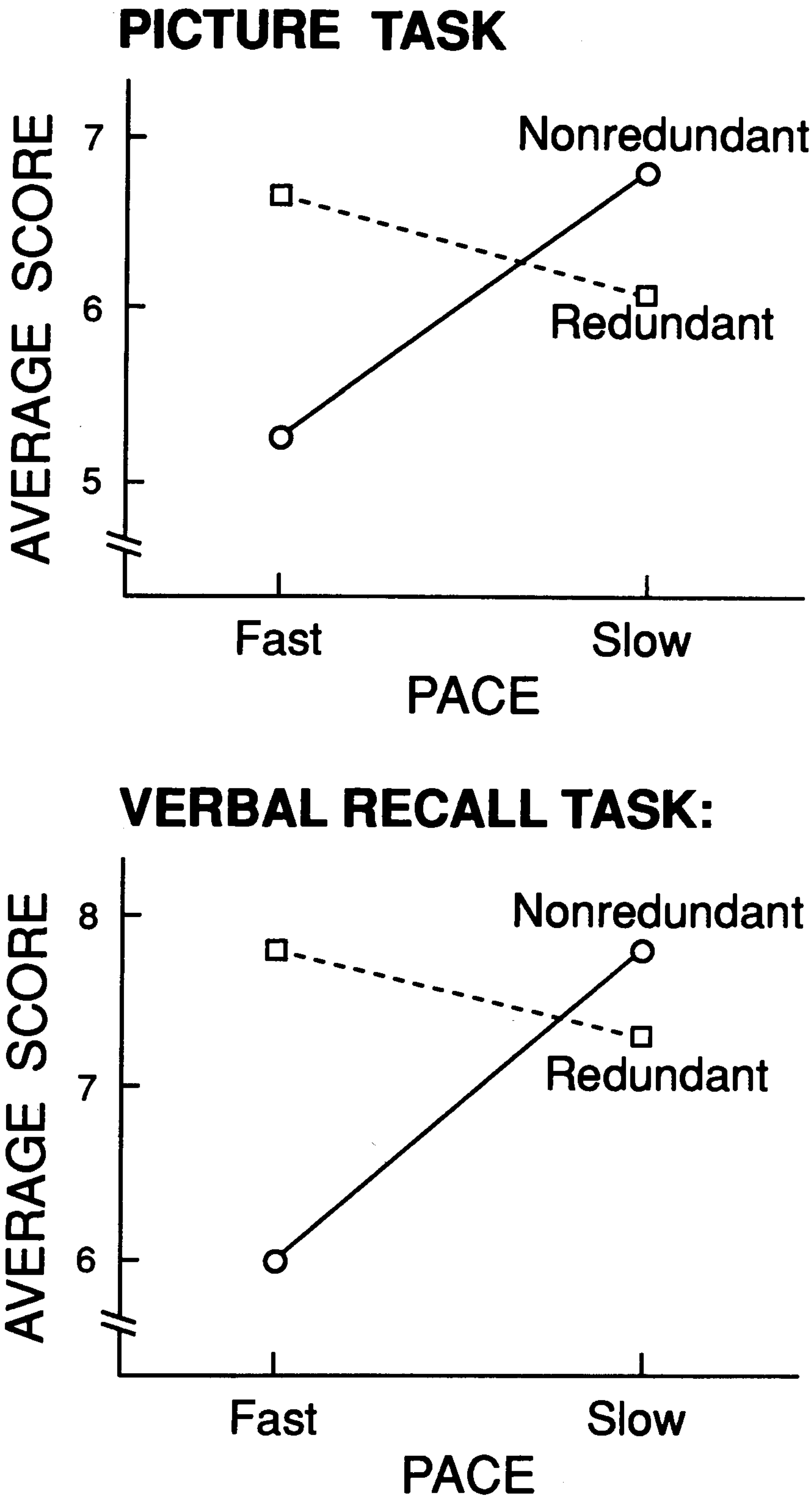

Figure 3. Average scores on the Picture Task and the Verbal Recall Task showing Pace by Redundancy interactions.

As shown in Table 3, a similar pattern of mean scores was obtained for Verbal Recall by Condition. Mean Verbal Recall scores by Condition were 6.0 (*SD* = 4.8), 7.8 (*SD* = 6.0), 7.8 (*SD* = 4.7), and 7.3 (*SD* = 6.5), for the fast nonredundant, fast redundant, slow nonredundant, and slow redundant conditions (Conditions 1 to 4) respectively. (Note that n = 28 for Condition 2 and 3, and n = 24 for Condition 4, due to missing data). However, this variation in Verbal Recall scores by Pace and Redundancy was not statistically reliable for either main effects or the interaction, as shown in a two-way ANOVA (see Figure 3).

Examination of Secondary Variables

Several other variables were quantified and examined to assess whether the multivariate models to be investigated were adequately specified, to check assumptions about the six main variables selected for inclusion, or to examine in an exploratory way characteristics of subpopulations of students.

Sex. Of the participants, 53 were boys and 67 were girls. As shown in Table 4, boys scored higher on the *TOLD*, on average, than did girls ($t = 2.42$; $p \leq .05$; $M = 18.3$ and 17.0, respectively). On the other hand, girls paid more attention to the lesson, on average, than did boys ($t = 2.34$; $p \leq .05$; $M = 71.2$ and 63.5, respectively). There were no statistically reliable differences between boys and girls on either of the two learning outcome measures, Picture Task and Verbal Recall. There were no statistically reliable interactions of sex with grade and/or condition for *TOLD*, Attention, Picture Task, or Verbal Recall.

Table 4
Mean Scores on Measures of Language Ability (*TOLD*), Attention to the Lesson, Picture Task, and Verbal Recall for Boys and Girls

		Measures			
	n	TOLD	Attention	Picture Task	Verbal Recall[a]
Boys	53				
M		18.3[b]	63.5[c]	6.3	6.8
SD		2.8	18.1	2.2	5.6
Girls	67				
M		17.0[b]	71.2[c]	6.2	7.5
SD		3.1	17.6	2.4	5.4

[a]For boys, $n = 50$, and for girls, $n = 60$.
[b]$t = 2.42$; $p \leq .05$.
[c]$t = 2.34$; $p \leq .05$.

As participants had not been expected to differ in language ability or attention to a lesson on the basis of sex, this variable was not initially included in the hypothesized causal model. However, because of the differences between boys and girls on *TOLD* and Attention, an alternative path model including sex as an exogenous variable was subsequently examined.

Grade and age. While the majority of the participants were enrolled in grade 2, some grade 1 and grade 3 students also participated. One-way ANOVAs of *TOLD*, Attention, Picture Task and Verbal Recall scores by grade showed no statistically reliable differences by grade for any of these variables. There were also no interactions of grade with sex and/or condition. One-way ANOVAs using years of age (6, 7 8, or 9) also showed no statistically reliable differences in *TOLD*, Attention, Picture Task, or Verbal Recall scores by age.

School. Students from five schools participated in the study. A one-way ANOVA of TOLD by School showed a reliable difference in students' language ability or English language proficiency across the schools, F (115, 4) = 4.63; $p \leq .01$. A one-way ANOVA of Attention by School also was statistically reliable, F (115, 4) = 2.45; $p \leq .05$. There were no reliable differences in the outcome measures, Picture Task and Verbal Recall by School, however. As the five schools were located in areas of the city that varied in socio-economic status and numbers of residents that were learning English as a second language, these differences across schools were not unexpected. As these differences were not relevant to the research questions, and as they did not compromise the design (as equal numbers of students from each school participated in each condition, with one exception), they were not examined further.

Characteristics of students with special learning needs. In each participating classroom, teachers were asked to identify students with specific special needs. Out of 120 students, 3 (2.5 %) were identified as Gifted. The following learning difficulties were also identified: English as a Second Language (ESL; $n = 12$), Learning Disability (LD; $n = 10$), Mental Handicap (MH; $n = 1$), Behavior Disorder or Emotional Disturbance (BD; $n = 4$), Speech or Language Delay or Disorder (SPLG; $n = 9$), and Other Special Need (OTH; $n = 3$).[1] In all, 30 students (25 %) were identified as having special needs other than giftedness.[2] As there were relatively few students in each separate category, these students were combined into one Special Needs group for further analysis. Students not identified as Special Needs or Gifted will henceforth be called Regular.

In looking at the mean scores of Special Needs, Regular, and Gifted students on the measure of preexisting language ability/English language proficiency, the *TOLD*, the process variable Attention measuring engagement, and the two learning outcome variables Picture Task and Verbal Recall, a not unexpected pattern is seen (see Table 5). Special Needs students obtained lower mean scores on the *TOLD*, Attention, Picture Task, and Verbal Recall measures than did Regular students. Gifted students obtained higher mean scores on the *TOLD*, Attention, and Picture Task measures and a higher median score

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1One of these students identified himself as hearing impaired to me, but was not identified as having a special need by his teacher.

2Some students were identified as having more than one special need, and this is why the preceding ns do not sum to 30.

(less influenced by deviations from normality than the mean) on the Verbal Recall measure than did Regular students. However, with only 3 Gifted students, these statistics must be interpreted very cautiously, and no further statistical examination is warranted. This pattern indicates that students identified by teachers as having special learning needs did, on average, score lower than regular students on independently administered measures of language, attention, and criterion referenced learning achievement. Effect sizes (*ES*) comparing Regular and Special Needs students' scores (calculated using Cohen's d-index with pooled standard deviation) were moderate to high for each measure (*TOLD ES* = 0.63; Attention *ES* = 0.50; Picture Task *ES* = 0.47; Verbal Recall *ES* = 0.80).

Table 5
Mean and Median Scores of Special Needs, Regular, and Gifted Students on Measures of Language Ability (*TOLD*), Attention, Picture Task, and Verbal Recall

	Learning Need		
	Special Needs	Regular	Gifted
		TOLD[a]	
n	30	87	3
M	16.1	18.0	20.7
SD	3.7	2.5	2.5
Md	16.0	19.0	21.0
		Attention	
n	30	87	3
M	60.9	70.0	72.8
SD	19.0	17.2	27.9
Md	60.9	72.0	85.2
		Picture Task[b]	
n	30	87	3
M	5.4	6.4	8.7
SD	2.0	2.3	2.1
Md	5.0	7.0	8.0
		Verbal Recall[c]	
n	29	78	3
M	4.3	8.2	7.3
SD	4.2	5.6	3.8
Md	3.0	7.0	9.0

[a]The distribution for Special Needs was moderately leptokurtotic.
[b]The distribution for Special Needs was moderately platykurtotic.
[c]The distributions for Special Needsand Regular were positively skewed and leptokurtotic.

The mean scores of Special Needs and Regular students on the *TOLD*, Attention, Picture Task, and Verbal Recall measures were also examined by condition (the statistics for the Special Needs groups must be considered tentative due to the small *n* per cell). On the *TOLD*, Regular students obtained similar scores across conditions, and their scores were higher than those for Special Needs students (see Table 6, Table 7, and Figure 4).

Table 6
Special Needs Students' Mean Scores and Standard Deviations for Language Ability (*TOLD*), Attention, Picture Task, and Verbal Recall, by Instructional Language Condition

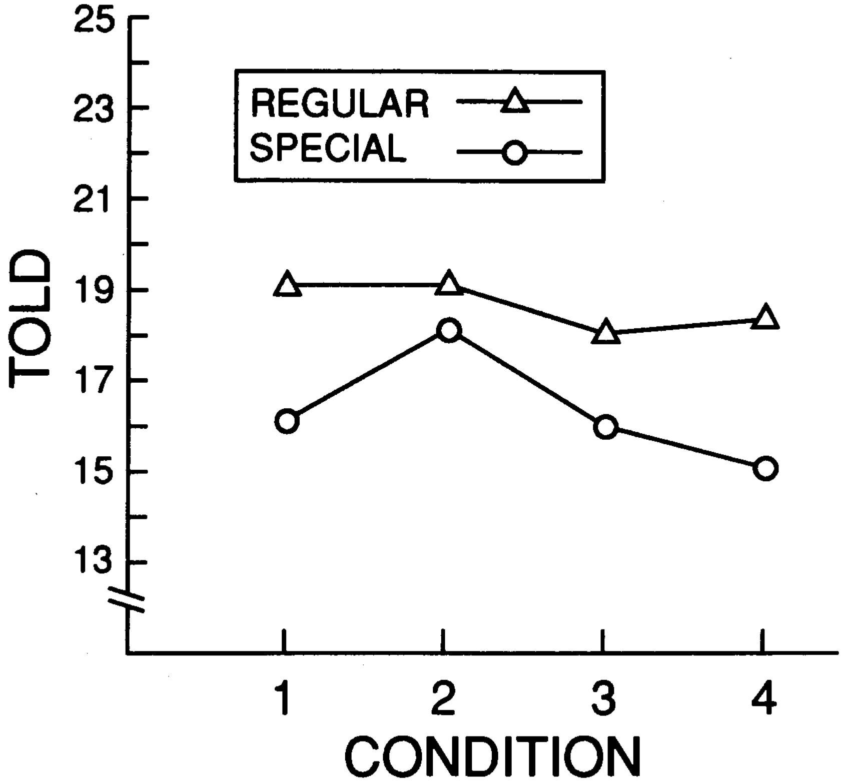
		Mean Score			
Condition	*n*	*TOLD*	Attention	Picture Task	Verbal Recall
1: Fast & Nonredundant	10	16.4 (4.2)	69.3 (22.8)	5.4 (1.7)	4.5 (2.6)
2: Fast & Redundant	7	17.9 (2.3)	68.1 (12.4)	6.0 (2.9)	5.3 (6.4)
3: Slow & Nonredundant	5	16.2 (2.9)	56.7 (13.9)	5.6 (1.7)	4.0 (3.1)
4: Slow & Redundant	8	14.1 (4.2)	46.9 (13.8)	4.9 (2.0)	3.4[a] (4.8)

Note. Standard deviation appears in brackets ().
[a]$n = 7$.

Table 7
Regular Students' Mean Scores and Standard Deviations for Language Ability (*TOLD*), Attention, Picture Task, and Verbal Recall, by Instructional Language Condition

		Mean Score			
Condition	*n*	*TOLD*	Attention	Picture Task	Verbal Recall
1: Fast & Nonredundant	19	18.0 (2.7)	69.7 (21.5)	5.2 (2.1)	6.5 (5.5)
2: Fast & Redundant	21	18.0 (2.6)	76.3 (11.1)	6.8 (2.5)	8.9[a] (6.0)
3: Slow & Nonredundant	25	17.9 (2.5)	68.4 (17.8)	7.0 (2.0)	8.7[b] (4.7)
4: Slow & Redundant	22	18.2 (2.4)	66.0 (16.6)	6.5 (2.3)	8.9[c] (6.6)

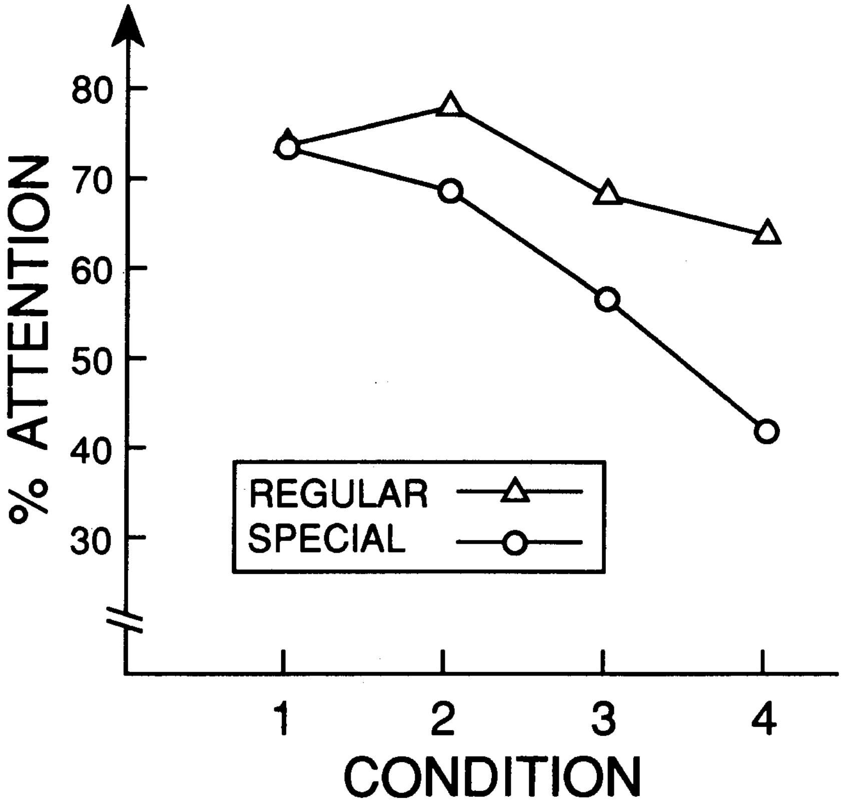
Note. Standard deviation appears in brackets ().
[a]$n = 19$. [b]$n = 23$. [c]$n = 17$.



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 4. Median *Test of Language Development (TOLD)* subtest scores for regular and special needs students by instructional language condition.

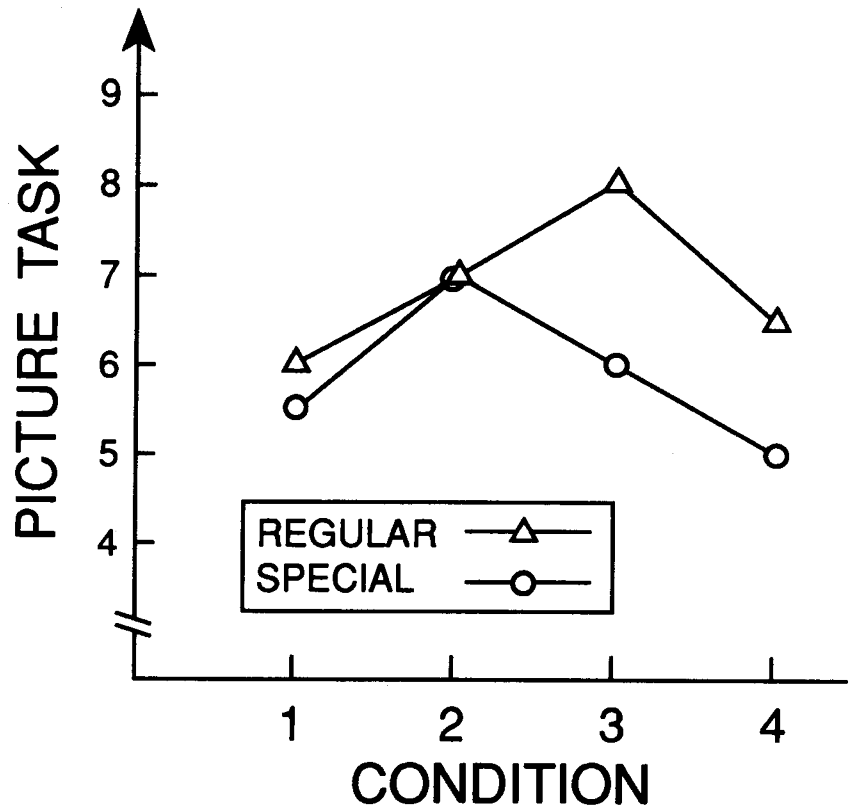
As can be seen in Table 6, Special Needs students paid progressively less attention to the chipmunk lesson as pace was reduced and redundancies were added. In contrast, as shown in Table 7, there was only a slight variation in the Regular students' attention to the lesson across instructional language conditions. This difference between Special Needs and Regular students is displayed graphically in Figure 5. (Median rather than mean scores are displayed in figures 4--7, as the median is less influenced by violation of normality and outliers than is the mean.)



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 5. Median percent attention for regular and special needs students by instructional language condition.

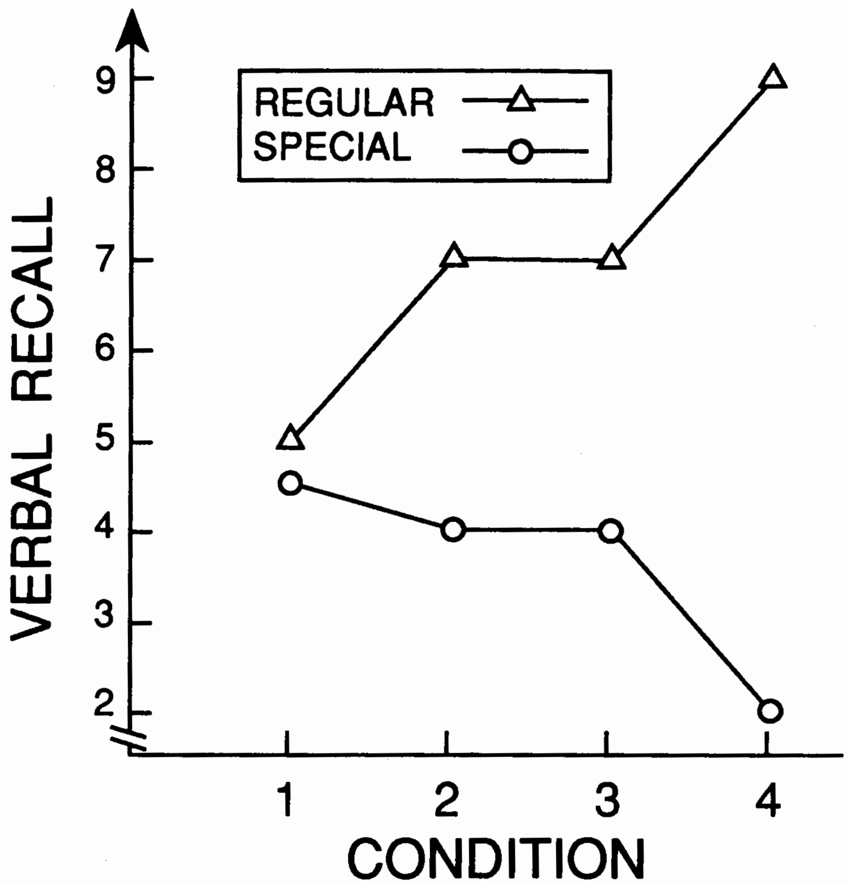
The pattern of mean scores on the two learning outcome measures, Picture Task and Verbal Recall, also appeared to differ between Special Needs and Regular students. In the fast paced conditions (Condition 1 and 2), Special Needs students obtained Picture Task scores similar to those obtained by Regular students, but Special Needs students who heard slow paced lessons recalled fewer facts about chipmunks than did Regular students who heard slow paced lessons. Regular students, as a group, obtained their highest Picture Task score in the slow nonredundant instructional language condition ($M = 7.0$; $Md = 8.0$). Special Needs students, as a group, scored highest on the Picture Task in the fast redundant condition ($M = 6.0$; $Md = 7.0$). These results are displayed in Table 6, Table 7, and Figure 6.



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 6. Median picture task scores for regular and special needs students by instructional language condition.

The apparent difference in learning outcome was most dramatic on the Verbal Recall measure. Special Needs and Regular students who heard the fast, nonredundant instructional language recalled a similar number of facts about chipmunks (*Md* = 4.5 and 5.0 respectively). However, when pace was slowed and redundancies were added, Regular students subsequently recalled more facts about chipmunks, while Special Needs students in slower and more redundant conditions recalled progressively fewer facts (see Figure 7).



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 7. Median verbal recall scores for regular and special needs students by instructional language condition.

Correlations

The correlation matrix in Table 8 includes the main variables Pace, Redundancy, *TOLD*, Attention, Picture Task, and Verbal Recall, as well as the secondary variables described above, Sex, Grade, and Age (in months). In addition, the variable Special Needs reflects the special needs designation described above. It is dummy coded -1 for students with teacher-identified learning difficulties, 0 for regular students not identified as having a special learning need, and the three students identified as gifted are omitted. The variable Language Level represents teachers' judgments of participating students' oral language abilities. It was included to be used as a check on the validity of the *TOLD* score as an indicator of language ability/proficiency. While teachers were asked to rate each participant's language as low, average or high, some teachers added medial ratings of low-average and high-average. Thus, this variable is coded from 1 (low) to 5 (high).

Table 8
Correlation Matrix

Variable	1	2	3	4	5	6
1 Pace		.00	-.08	-.23**	.09	.07
2 Redundancy			.00	-.03	.08	.06
3 *TOLD*				.13	.39***	.32***
4 Attention					.32***	.19*
5 Picture Task						.44***
6 Verbal Recall						
7 Sex						
8 Grade						
9 Age						
10 Special Needs						
11 Language Level						
12 Peer Attention						

Correlation Matrix (continued)

Variable	7	8	9	10	11	12
1 Pace	-.02	.00	-.04	.09	-.09	-.39***
2 Redundancy	.08	-.09	.00	-.01	-.01	-.04
3 *TOLD*	-.21*	.09	.03	.28**	.42***	-.06
4 Attention	.21*	-.10	-.19*	.22*	.22*	.31***
5 Picture Task	-.02	.09	.08	.19*	.40***	.03
6 Verbal Recall	.06	.07	.00	.31***	.35***	-.18
7 Sex		-.03	.00	.23**	.01	.14
8 Grade			.74***	-.10	.06	-.08
9 Age				-.24**	-.06	-.11
10 Special Needs					.40***	.05
11 Language Level						-.05
12 Peer Attention						

Note. Correlations with Special Needs involve 117 cases; correlations with Verbal Recall involve 110 cases. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

A final variable included in the correlation matrix, Peer Attention, has not been described previously. This variable represents peer attention to the chipmunk lesson, and it was generated post hoc to examine possible influences of peers on a student's attention during instruction. In viewing the attention videotapes, I observed that certain groups of six students seemed particularly attentive and others less so. As it seemed plausible that students would be affected by the behaviors of their peers in the group, and attend more or less to the lesson as a result, I calculated peer attention by averaging the attention scores of the five other members of each group, creating a jacknife-like variable. Thus, for each student, there is an Attention variable, representing his or her own percent attention to the lesson, and a Peer Attention variable, representing the average percent attention of the five other students in that group.

Main variables with main variables. The two instructional language variables, Pace and Redundancy were coded so that slow paced and redundant instructional language were each coded 1, and fast paced and nonredundant instructional language were each coded -1. Pace and Redundancy are orthogonal so their correlation is zero. As expected, Pace was not correlated with *TOLD*. Pace was negatively correlated with Attention, indicating that slower instructional language was related to less attention to the lesson. Pace was not reliably correlated with either of the outcome variables, Picture Task or Verbal Recall. Redundancy was not reliably correlated with *TOLD*, Attention, Picture Task, or Verbal Recall, nor was it correlated with any of the secondary variables. As will be discussed shortly, this pattern was also seen in the multiple correlations, and led to this variable being trimmed from path models.

TOLD was not correlated with Attention, but was reliably correlated with both learning outcome measures, Picture Task, and Verbal Recall. Percent attention was reliably correlated with both outcome measures. The two learning outcome measures were also reliably correlated These correlations between the main variables, excepting the nonreliable correlations for Redundancy, were consistent with the theoretical model postulated, and supported proceeding with the multiple regression analysis to test the hypothesized causal model.

Secondary variables with main variables. Sex was not correlated with either of the learning outcome variables (Picture Task and Verbal Recall). However, Sex was reliably correlated with *TOLD* in that boys scored higher on this language measure, and Sex was reliably correlated with Attention in that girls attended to the lesson more. As noted above, this finding led to developing an alternative path model that included Sex as a variable.

Grade was not correlated with any of the main variables, but Age negatively correlated with attention; younger children attended more to the lesson. Age was not correlated with any of the other main variables.

The variable Special Needs was not correlated with either of the instructional language variables, Pace and Redundancy. This is as one would expect, as Special Needs reflects pre-existing student characteristics, and participants were randomly assigned to instructional language conditions. Special Needs was, however, reliably correlated with *TOLD*, Attention, Picture Task, and Verbal Recall. Students not identified by their teachers as having special learning needs obtained higher *TOLD* scores, on average, than did students identified as having a learning difficulty. Regular students paid more attention to the lesson, and scored higher on the Picture Task and on the Verbal Recall task, than did students identified as having learning difficulties. These results are consistent with widely accepted findings from decades of research with special needs learners, and can be interpreted as supporting the validity of the measures used in this study. Alternatively, these results can be interpreted as indicators of the teachers' accuracy in identifying special needs learners in their classrooms. That is, their designations were consistent with the scores students subsequently obtained on language, attention, and criterion-referenced learning outcome measures during instructional activities.

The teachers' judgments of students' oral language abilities, Language Level, was not correlated with instructional language condition, as expected. Language Level was reliably correlated with *TOLD* scores ($r = .42$; $p \leq .001$). This supports the validity of *TOLD* as a language measure for these students, and is also indicative of these teachers' abilities to judge the language skills of their students. Language Level was also correlated with Attention while *TOLD* was not. Language Level was correlated with the Picture Task, and with Verbal Recall.

Peer Attention was reliably correlated with Attention, suggesting a relationship between individual attention and degree of attention of peers in the group. Note, of course, that this correlation could be due to causal influences of an unknown third variable. Peer Attention was not correlated with Picture Task, but there was a trend for Peer Attention to be negatively correlated with Verbal Recall ($r = -.18$; $p = .06$). This pattern of correlations suggested that development of an alternative path model including Peer Attention might be warranted.

Secondary variables with secondary variables. In addition to the correlations described above, Sex was also correlated with Special Needs. This finding that boys are more likely to be identified as having learning difficulties is consistent with widely accepted findings in the special needs literature. Age was correlated with Special Needs indicating that learning difficulties were more likely to be identified for older children than younger children. Finally, teachers' identification of students' special learning needs, and their judgments of students' language abilities were reliably correlated.

The simple correlations among variables in the study support the a priori theoretically postulated links between constructs, in large part, and warranted continuing with the path analysis and multivariate comparison of means as planned. In addition, validity of the measures chosen was supported. Furthermore, some additional variables of interest (Sex, Special Needs, and Peer Attention), were identified for inclusion in alternative path models.

Path Analyses

This consists of two parts. I present the path model obtained by testing the theoretical model postulated prior to collecting the data. Then I present alternative models obtained by testing the theoretically postulated model on subsets of cases, or derived post hoc by including additional variables that appear to be related to outcome variables.

Theoretical Model

The theoretical model, described in chapter 2, postulates causal links among a set of variables based on theoretical considerations. While the causal structure was postulated a priori, the strength of effects, both direct and indirect, were not hypothesized, and in this sense, this test of the model using path analysis methods can be viewed as "exploratory" rather than "confirmatory." Nevertheless, this is not an attempt to use the data (a set of correlations) to derive an explanatory causal scheme, but rather is a test of the tenability of the a priori model. The values in the model show strengths of effects and percent of variance of endogenous variables explained by exogenous variables, given the assumption that certain variables can be taken as effects of certain other variables, but does not show that certain variables are causes or that other variables are effects. These causal inferences rest on the theory (see Pedhazur, 1982, for further discussion).

As shown in the fully specified recursive model in Figure 8, the numerical values of which were derived using a simultaneous entry approach to regression analysis, some percent of the variance of each of the endogenous variables is explained by the exogenous variables. The variables *TOLD*, Pace, and Redundancy account for a small but statistically reliable 7% of the variance in Attention ($p \leq .05$); the variables *TOLD*, Pace, Redundancy, and Attention account for 27% of the variance in Picture Task ($p \leq .001$); and the variables *TOLD*, Pace, Redundancy, Attention and Picture Task account for 24% of the variance in Verbal Recall ($p \leq .001$).

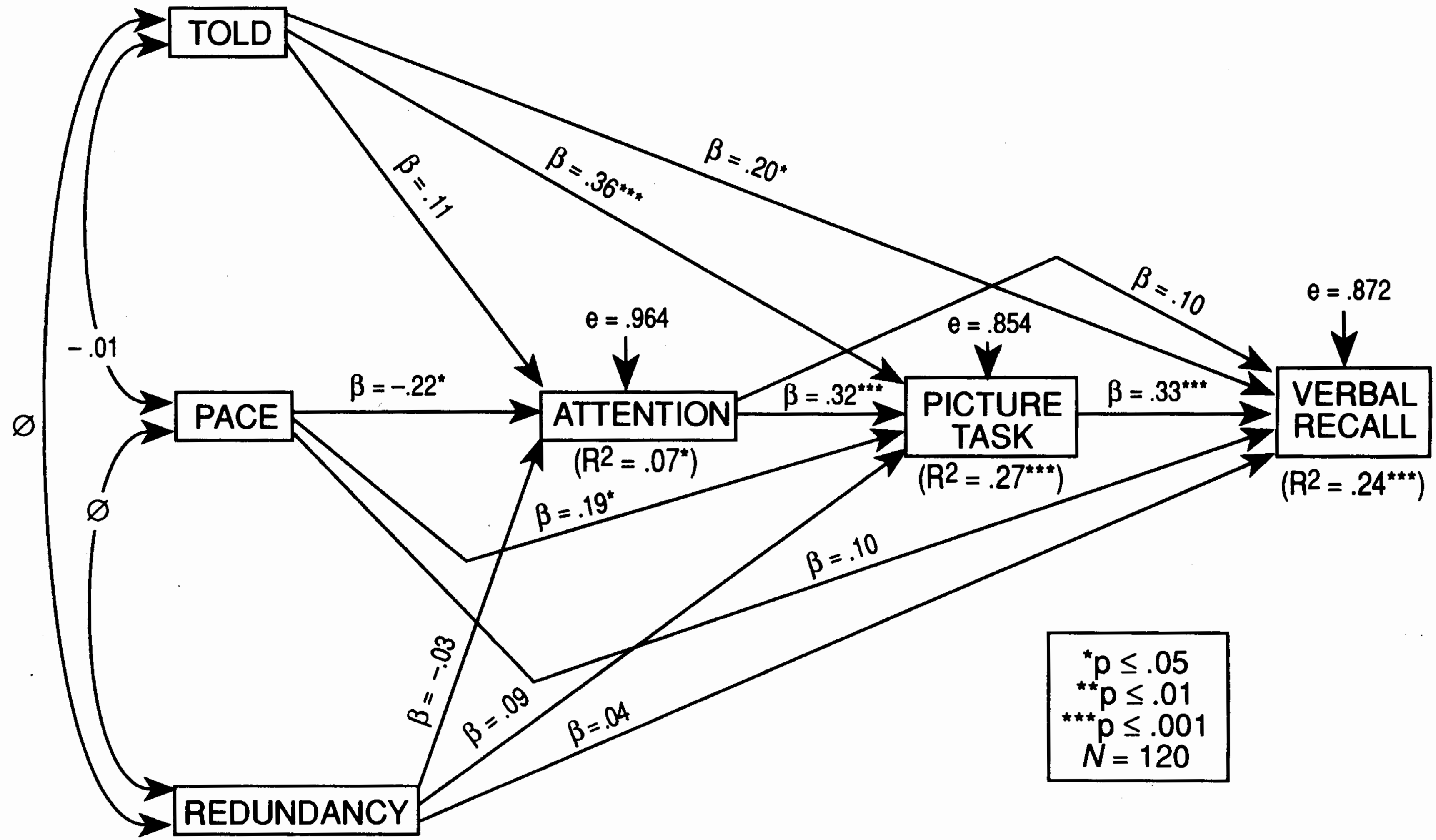
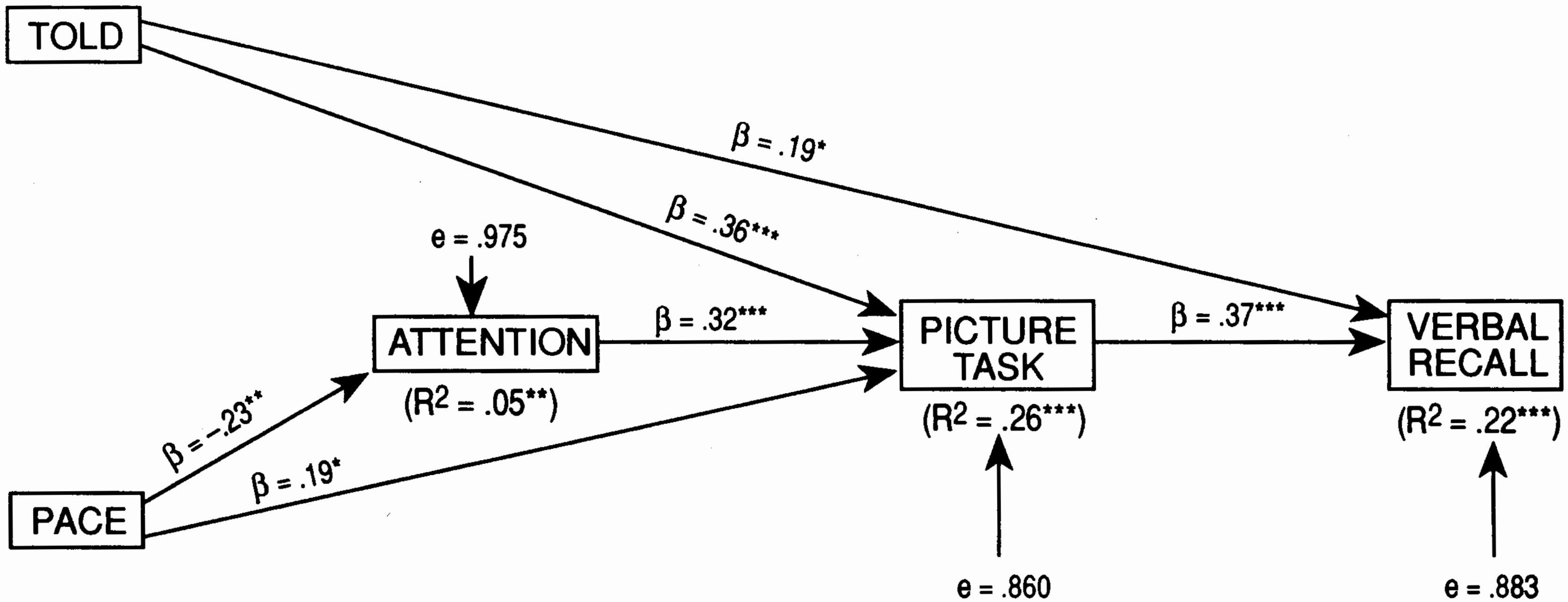


Figure 8. Hypothesized causal model, fully-specified.

Several statistically reliable direct effects of prior variables on subsequent variables are also shown in this model (Figure 8). The path coefficient (beta, standardized regression coefficient) of the Pace to Attention path shows that slower pace of instructional language corresponds to reduced attention. Higher scores on the *TOLD*, slower paced instructional language, and higher rates of attention are all related to higher Picture Task scores. Higher *TOLD* scores and higher Picture Task scores correspond to higher Verbal Recall scores (and it is likely that some portion of this effect is due to indirect effects of prior variables).

Also shown in this model is that the correlations among *TOLD*, Pace, and Redundancy approach zero, indicating that the assumption of independence of exogenous variables has not been violated. The size of the error terms indicates, clearly, that there are important variables that have not been included this model. The several statistically nonreliable path coefficients suggest that theory trimming is in order. In particular, Redundancy seems to be unneccesary in this causal model. Finally, the statistically reliable R^2 values for each of the endogenous variables (Attention, Picture Task and Verbal Recall) and the several statistically reliable paths suggest that the hypothesized causal model has withstood the test; that is, it has not been disconfirmed.

Next, a theory-trimmed version of the original theoretical model was derived. Beginning with the regression of Attention on *TOLD*, Pace, and Redundancy, the weakest path was set to zero (in this case, Redundancy to Attention), and betas, R^2, and other statistics were calculated and evaluated. Then the weakest remaining path was set to zero, and so forth, until only the statistically reliable relationships remained in the model. As can be seen in the graphic representation of the theory trimmed model, Figure 9, this yielded negligible increases in the error terms, and highly reliable R^2s.



Indirect Effects:
PACE (via ATTENTION) on PICTURE TASK = –.07
TOLD (via PICTURE TASK) on VERBAL RECALL = .13
ATTENTION (via PICTURE TASK) on VERBAL RECALL = .12
PACE (via PICTURE TASK) on VERBAL RECALL = .07
PACE (via ATTENTION, PICTURE TASK) on VERBAL RECALL = –.03

*$p \leq .05$
**$p \leq .01$
***$p \leq .001$
$N = 120$

Figure 9. Theory-trimmed causal model.

Direct effects remaining in the model included paths from Pace to Attention, *TOLD* to Picture Task, Pace to Picture Task, Attention to Picture Task, *TOLD* to Verbal Recall, and Picture Task to Verbal Recall. These correlations were decomposed (following Pedhazur, 1982) to determine the indirect effects of variables in the model on the endogenous variables, as shown in Figure 9. This model was judged the strongest representation of the inferred causal links between the original variables selected for inclusion.

Alternative Models

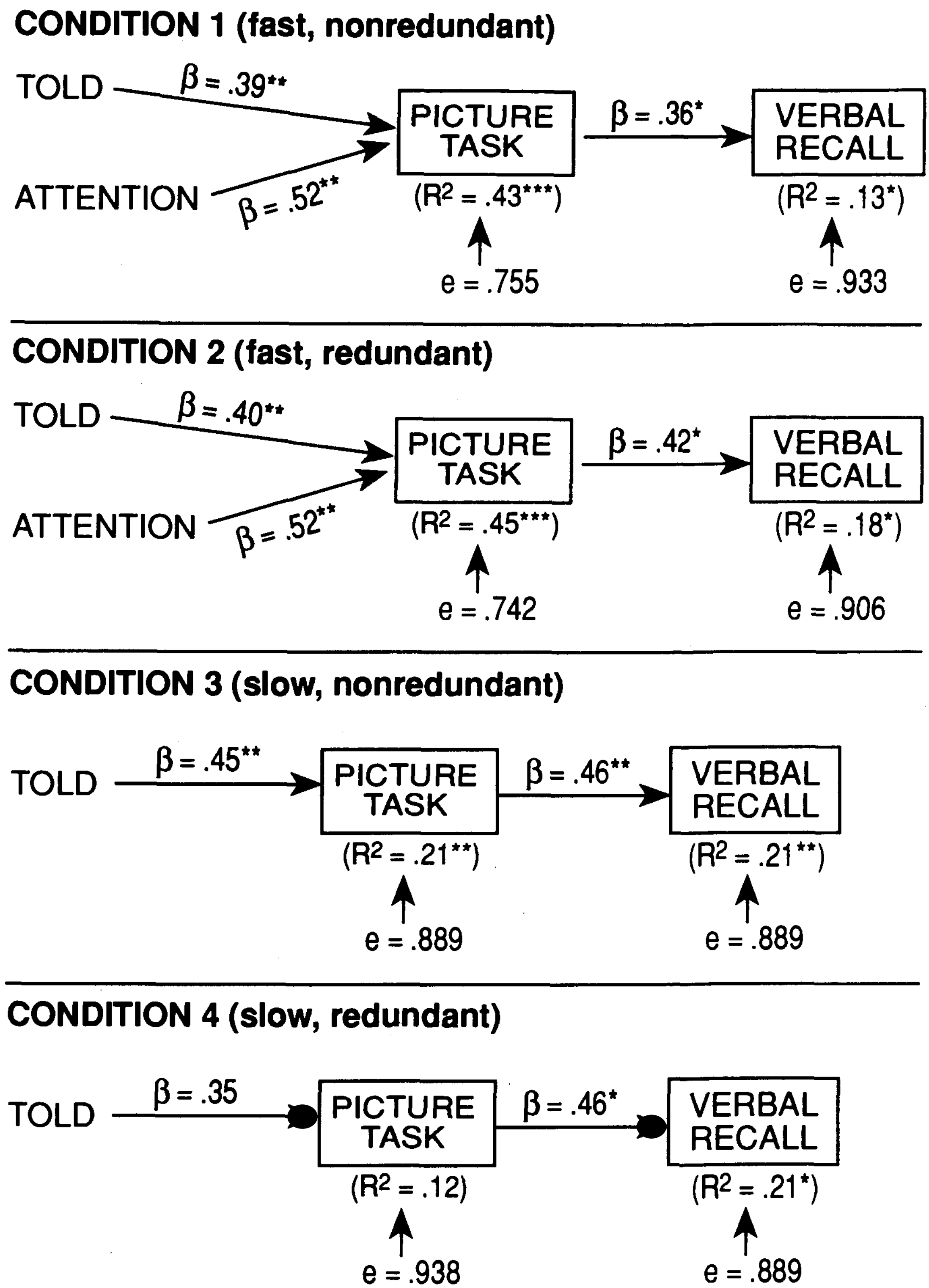
In addition to testing the model postulated a priori, several alternative path models were developed. Some of these tested the a priori model on a subset of cases, a traditional approach taken to path analysis when it might be argued that combining the data violates one of the fundamental assumptions of path analysis. These include separate models for the four instructional language conditions, and separate models for slow-paced and fast-paced instructional language.

Other alternative models were derived following preliminary analysis of the data. As these models were developed post hoc based on patterns observed in the data, they cannot be seen as tests of the tenability of theoretically derived causal links. Rather, they represent theoretically plausible relationships between sequential variables for future testing on a different data set. As each includes variables not originally included in the theoretical model, these alternative models suggest directions to follow in rethinking the possible causal relationships in this type of school learning. The alternative models include the variables Special Needs and Peer Attention, as well as models developed separately for boys and girls. Given the support for the theoretical model as discussed above, a hierarchical approach to regression was used for the alternative models.

Separate path models. It is possible to argue, with respect to the forgoing theoretical model, that one of the assumptions underlying path analysis (see Pedhazur, 1982, p. 582) was violated. This is that, while variables are assumed to be measured on an interval scale, each of the two variables Pace and Redundancy had only two levels and thus could be viewed as dichotomous. On the other hand, one could argue that Pace was measured as words per minute, which is clearly an interval measure, but that data points were collected at only two levels of this (interval) measure, and that therefore this is not a serious violation of assumptions. A similar argument could be made for Redundancy.

Nevertheless, the classic approach to path analysis when some exogenous variables might be considered factors rather than continuous interval measures is to postulate and test separate path models for each condition. While this allays concerns about violating an assumption, it is also weaker in that the relative influences of the factors in combination with the other exogenous variables on the variables taken as effects cannot be directly seen. Furthermore, as this results in a small N for each path model, the relationships between only a small number of variables can be confidentially measured (Kleinbaum, Kupper, & Muller, 1988).

Figure 10 shows the theory-trimmed causal models obtained for each of the four conditions. For each model, a hierarchical approach to analysis was used, and effects of variables were assumed to be *TOLD* to Attention to Picture Task to Verbal Recall. For each model, N was 30 (except there were 2 missing data points for Verbal Recall in each of Conditions 2 and 3, and 6 missing data points in Condition 4). All paths detectable at $p > .05$ were set to zero in turn (except for *TOLD* to Picture Task in Condition 4, as shown).

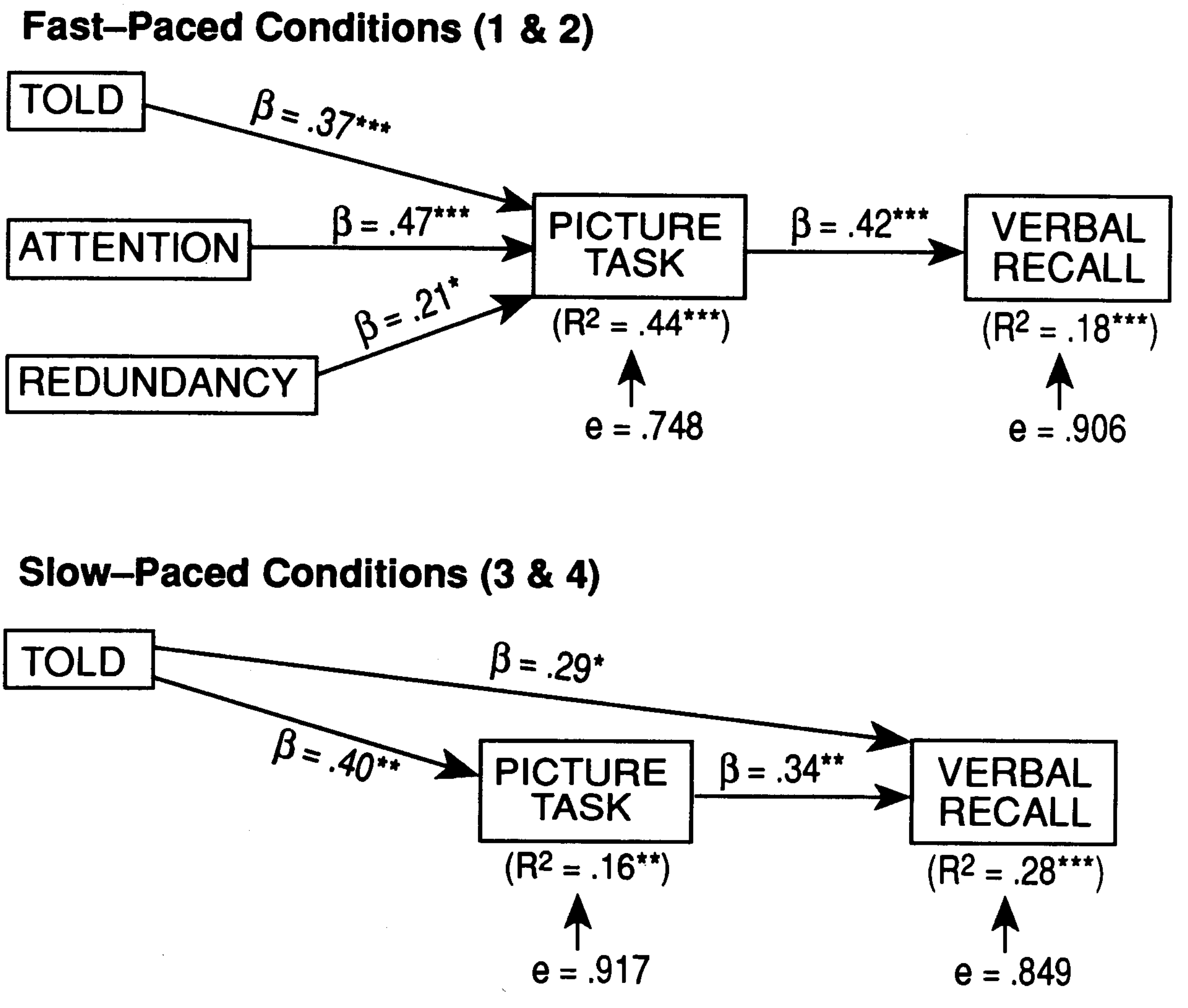


Note: All statistically nonreliable paths were set to zero, except as shown in condition 4. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. $N = 30$ for each condition, except for VERBAL RECALL, as described in the text.

Figure 10. Separate causal models for instructional language conditions.

Models for the fast nonredundant and the fast redundant lessons were consistent with the postulated causal structure. However, both must be interpreted cautiously due to the small sample size of each. The values obtained for the two slow-paced conditions, especially when instructional language was redundant, supported the postulated causal relationships less strongly. Attention did not play a statistically reliable role in either model, and in Condition 4, the only reliable effect was Picture Task to Verbal Recall. Clearly, in Condition 4, some other factors were at play, as neither language level as measured by *TOLD*, nor percent attention, reliably and directly accounted for Picture Task or Verbal Recall scores.

As the models obtained for the two fast-paced conditions were similar, and the models obtained for the two slow-paced conditions were also similar, I combined conditions to derive values for a fast-paced model and a slow-paced model. This approach was also supported by the results obtained on the full data set which showed that, of the two instructional language variables, only Pace contributed reliably to the variance of endogenous variables. The causal models for the fast-paced and slow-paced instructional language conditions are shown in Figure 11. Both were derived by first regressing Attention on *TOLD* and Redundancy, then Picture Task on *TOLD*, Redundancy, and Attention, then Verbal Recall on *TOLD*, Redundancy, Attention, and Picture Task. A hierarchical approach was used, and nonreliable paths were set to zero in turn.



Note: N = 60 for each model. All statistically nonreliable paths were set to zero.
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$.

Figure 11. Separate causal models for fast-paced and slow-paced instructional language conditions.

As can be seen in Figure 11, the pattern of relationships between the variables differed considerably between the two models. In the fast-paced conditions, *TOLD*, Redundancy, and Attention accounted for almost half the variance in Picture Task, and about a fifth of the variance in Verbal Recall. In the slow-paced conditions, only 16% of the variance in the Picture Task, and a little over a quarter of the variance in Verbal Recall was accounted for. Thus language ability/proficiency, redundancy of the instructional language, and percent attention all helped explain the learning outcome scores when students heard a fast-paced lesson, but when students heard a slow-paced lesson, language ability/proficiency was the only variable to have a statistically reliable effect.

Alternative post hoc models. Preliminary statistical analysis suggested that whether students were designated by their teachers as having special learning needs might contribute uniquely to some of the variance in the learning outcome scores. Similarly, it appeared that attention paid to the lesson by peers in the small group might mediate individual students' attention levels. As only 5% of the variance in Attention, 26% of the variance in Picture Task, and 22% of the variance in Verbal Recall was explained in the theory-trimmed a priori model, it seemed valuable to add these variables to the original model and retest to see if a more explanatory model was then achieved. There were also indications that Sex might be an important contributing variable, but as I considered Sex to be statistically dichotomous (although not necessarily functionally dichotomous), it will be discussed separately below.

In formulating a causal model containing these two variables, I theorized that Special Needs ought to be viewed as an exogenous variable partially explaining *TOLD*. Whether someone is learning English as a second language, has a known speech and language disorder, or has been identified as having a learning disability could logically be expected to predict how that person might score on a test of receptive vocabulary. Thus, I considered Special Needs to be logically prior to *TOLD*.

In contrast, Peer Attention was seen as mediating students' attention to the lesson. I theorized that just as there was an effect of Pace on individual students' Attention, Peer Attention would necessarily be affected by Pace and would in turn influence an individual's attention. So Peer Attention was seen as mediating Pace and Attention. Redundancy was not considered in this model because it failed to contribute reliably in the original model. The hypothesized causal model containing Special Needs and Peer Attention is shown in Figure 12.

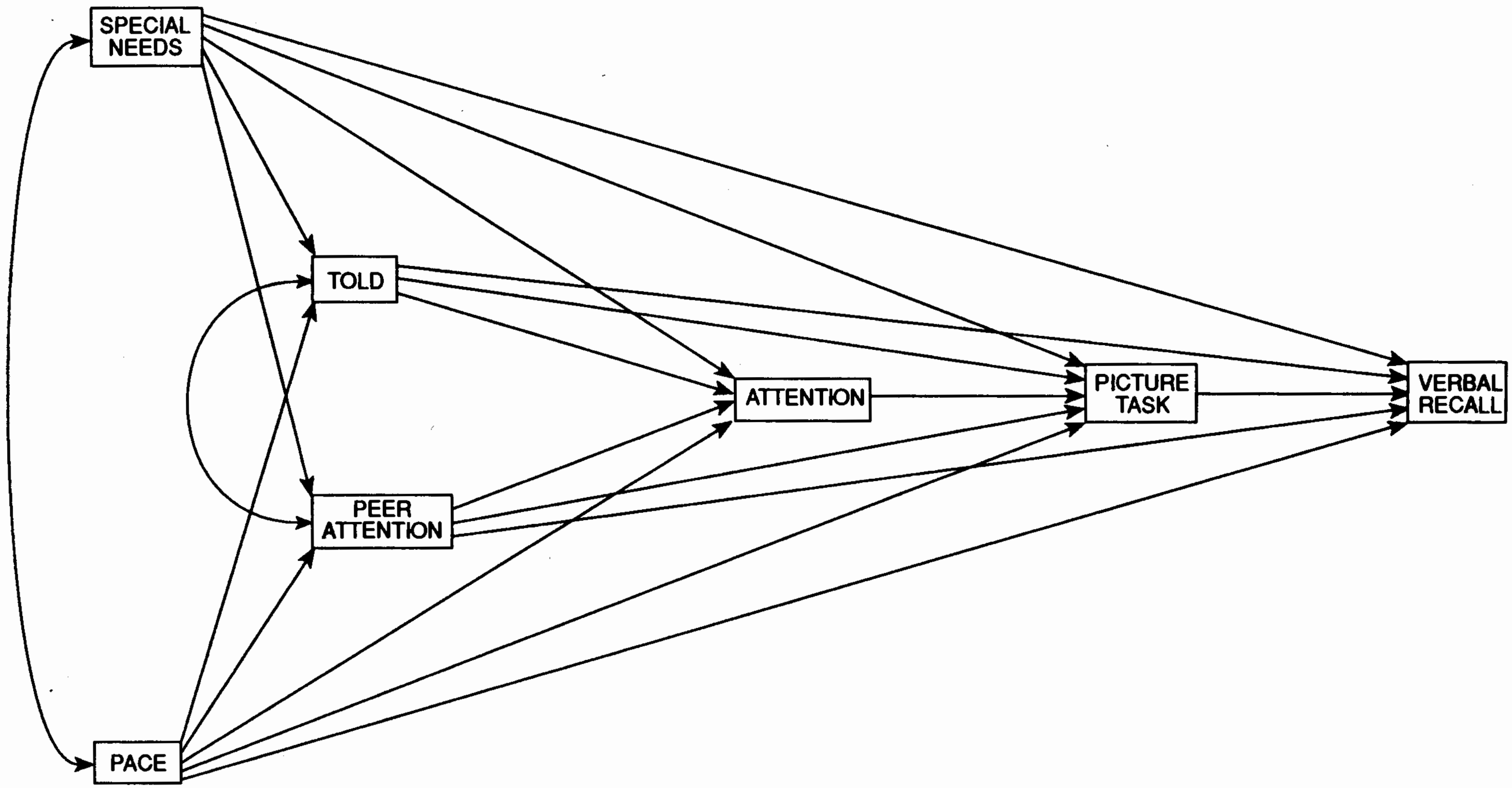
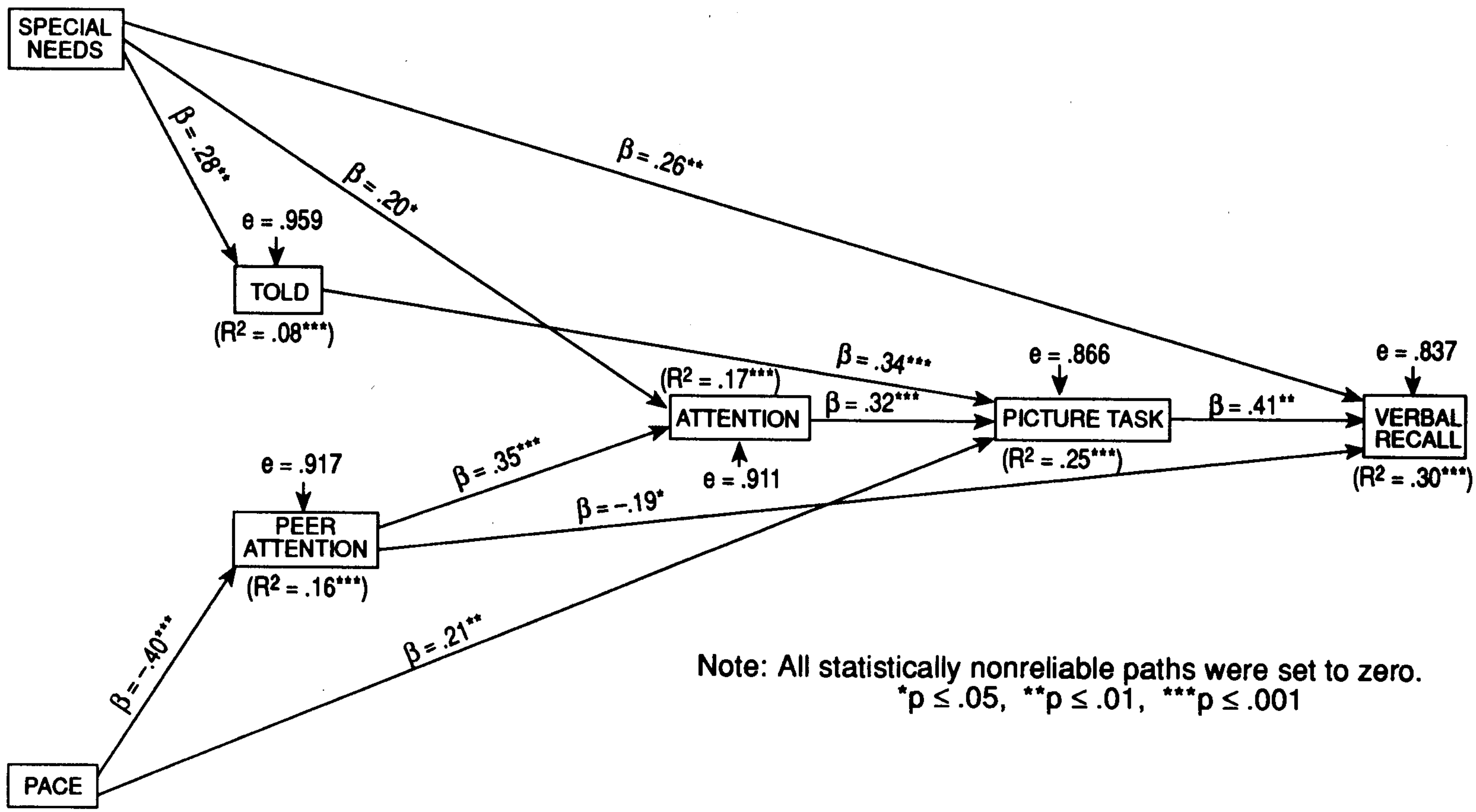


Figure 12. Alternative causal model including special needs and peer attention.

Pedhazur (1982) points out that it is important for exogenous variables to be uncorrelated. In this study, there was no reason to expect that Special Needs and Pace would be correlated as participants were assigned to instructional language conditions randomly, and, in fact, they were not ($r = .02$). In addition, in order to analyze this as a recursive model, it was also important that *TOLD* and Peer Attention were not correlated. There was no reason to expect that individual students' language scores would be related to the amount of attention five peers paid to a lesson, given that the groups were assigned randomly, and, in fact, they were not correlated ($r = -.06$).

Figure 13 shows the theory-trimmed causal model including Peer Attention and Special Needs. Clearly, adding these two variables to the model explained some of the previously unaccounted for variance in Attention and Verbal Recall, but the R^2 for Picture Task was essentially unchanged. Special Needs has statistically reliable direct effects on *TOLD*, Attention, and Verbal Recall, showing that Regular students had higher *TOLD* scores, attended more to the lesson, and recalled more facts about chipmunks in the individual interviews than Special Needs students. Peer Attention has reliable direct effects on Attention and Verbal Recall, showing that an individual student's attention is partially explained by the amount peers attented to the lesson. The negative correspondence between Peer Attention and Verbal Recall does not make sense theoretically. Perhaps it is artifactually due to regression toward the mean.

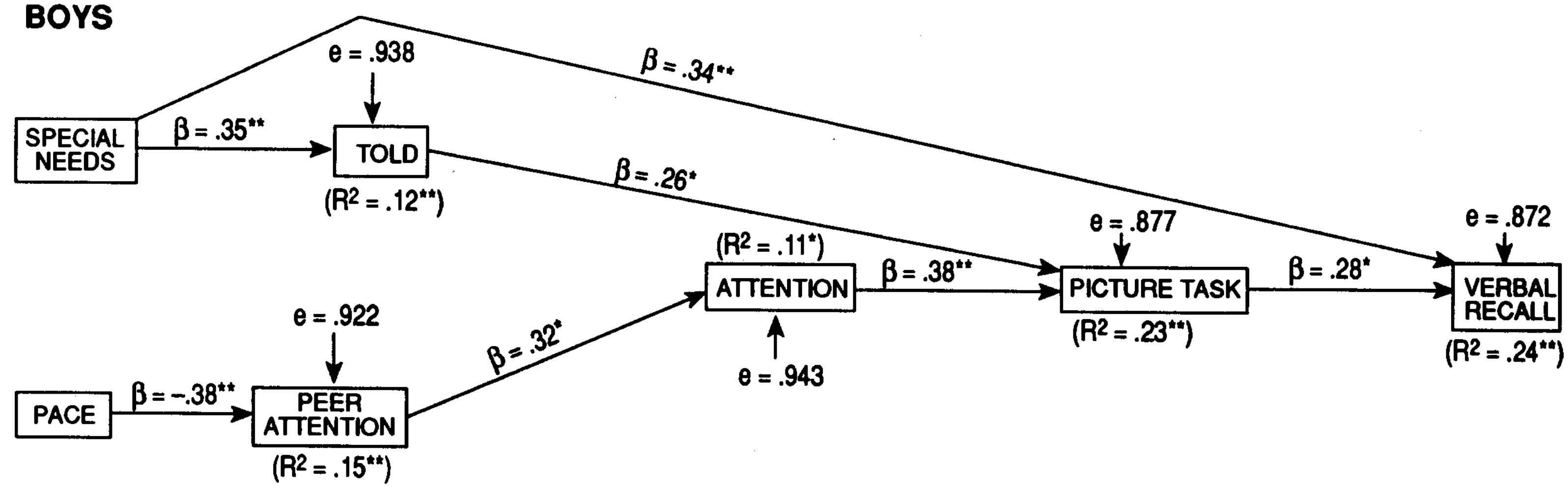
Interpretation of this model must remain highly speculative, however. As it was derived from the same data on which it was tested, a true test of this model must await another sample of grade 2 students. As the 10 paths were obtained from only 117 participants, the minimum ratio of 10 subjects for each variable suggested by Kleinbaum, Kupper, and Muller (1988) is nearly reached and the more conservative ratio of 15 to 1 is exceeded. Finally, as I coded Special Needs as a dichotomous variable (although functionally, the students designated as Special Needs had heterogeneous types of learning needs), it might be advisable to retest this model on an adequately large sample that models for both Special Needs and Regular students can be tested separately.



Note: All statistically nonreliable paths were set to zero.
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Figure 13. Theory-trimmed model including special needs and peer attention.

The last path models that were examined were separate models for boys and girls (51 and 66 participants respectively, with the three gifted students omitted). The variables with the causal structure described for the theory-trimmed model including Special Needs and Peer Attention (shown in Figure 13) were tested for each subset of participants respectively. Statistically nonreliable paths were trimmed (with one exception in the girls' model, as discussed below) to achieve best models for boys and girls (see Figure 14).



Note: N = 51 for Boys and N = 66 for Girls.
All statistically nonreliable paths were set to zero.
$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

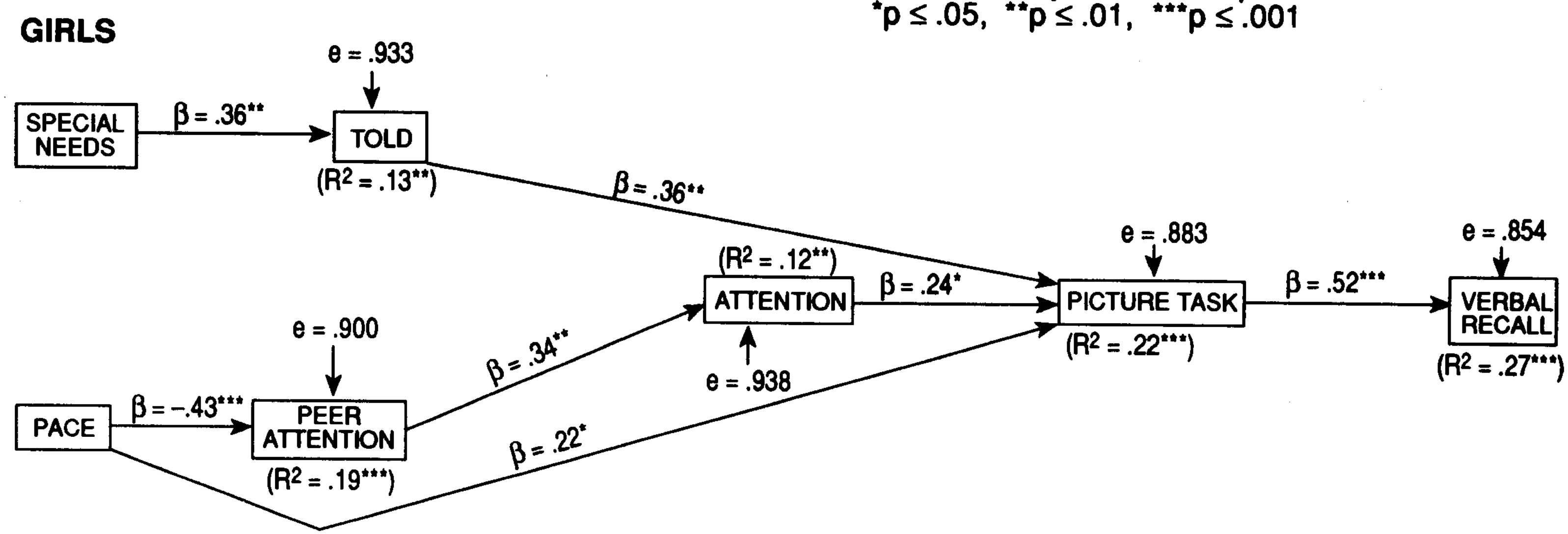


Figure 14. Causal models for boys and girls.

While the girls' and boys' models appear similar, there are some interesting differences. First, there is a direct effect of Special Needs on Verbal Recall for boys but not for girls. Attention has a stronger direct effect on Picture Task for boys than for girls. In the girls' model there is a direct effect of Pace on Picture Task, while this path has been trimmed from the boys' model as statistically nonreliable. *TOLD* has a stronger direct effect on Picture Task, and Picture Task has a stronger direct effect on Verbal Recall for girls than for boys. Most of these differences would seem to follow from girls' greater tendency to attend to the lesson, and boys' higher *TOLD* scores, on average.

Both models must be interpreted with caution for the same reasons as the model discussed above in Figure 13. The number of variables per sample sizes might have resulted in overfitting (Kleinbaum, Kupper, & Muller, 1988; Tabachnick & Fidell, 1983). In addition, Pace and *TOLD* appeared negatively correlated ($r = -.28$) which violates the theoretically assumed independence that should have been achieved by the random assignment of participants to conditions.

Multivariate Analysis of Covariance

A two-by-two between-subjects multivariate analysis of covariance (MANCOVA) was conducted using the instructional language variables Pace (fast and slow) and Redundancy (nonredundant and redundant) as independent variables, *TOLD* as a covariate, and Attention, Picture Task, and Verbal Recall as multiple dependent variables. The SPSS/PC+ procedure MANOVA was used, with the hierarchical option. Order of entry for factors was Pace then Redundancy. This section includes discussion of the design, tests of assumptions, outliers and how they were handled, results of the omnibus MANCOVA, and results of the stepdown MANCOVA.

Design

MANOVA or MANCOVA are not called for unless the dependent variables are correlated (Norusis, 1990; Tabachnick & Fidell, 1983). A Bartlett test of sphericity, with all cases included except those 10 with missing data, produced a value of 23.21 with 3 degrees of freedom, and an observed significance level less than .001. This indicated that the dependent variables were correlated, and so a multivariate analysis of variance rather than univariate analyses was appropriate.

Choice of variables and order in which they should enter are important considerations in MANCOVA. As the a priori reasoning about the six main variables and their causal structure was largely supported by the preceding descriptive analysis and causal modelling, these six variables were used in the MANCOVA. Redundancy was included rather than omitted because in the separate causal models by condition, it appeared to interact with Pace in explaining Picture Task in some conditions. *TOLD* was handled as a covariate because it represented pre-existing differences in individual students that explained some of the variance in Attention, Picture Task, and Verbal Recall. An alternative that was not pursued would have been to treat *TOLD* as a third factor, either by arbitrarily dividing it into levels or, perhaps, substituting the three-level Language Level variable in its place.

I limited the analysis to a priori contrasts of the six main variables. This approach avoided the risks of compounding error through post hoc comparisons. Order of entry reflected the actual sequential order of events, as well as the causal structure previously examined. In SPSS/PC+, the regression solution UNIQUE was used. This approach uses unweighted cell means rather than weighting cells by sample size.

An omnibus MANCOVA, with Pace and Redundancy as factors, *TOLD* as the covariate, and Attention, Picture Task, and Verbal Recall as dependent variables was run, and based on those results, a stepdown MANCOVA was then conducted. In the stepdown analysis, *TOLD* entered as a covariate, and Attention was analyzed as the dependent variable. In the next step, *TOLD* then Attention entered hierarchically (essentially, both functioned as covariates), and Picture Task was examined as the dependent variable. At the last step, *TOLD*, Attention, then Picture Task entered hierarchically, and the dependent variable was Verbal Recall. This approach favours dependent variables entered at an earlier step over those entered at a later step, and is analogous to the hierachical approach used in multiple regression.

Assumptions and Outliers

As discussed earlier, the planned design included equal data points in every cell, but Verbal Recall data were lost for ten participants. Thus, when the cases with missing data points were omitted, the number remaining in each cell were: Condition 1, 30; Condition 2, 28; Condition 3, 28; and Condition 4, 24. As the cells were still fairly equal in size, and as each cell had more than 20 degrees of freedom for error (in the univariate case), and as MANOVA is relatively robust to violations of normality due to skewness at this sample size, this was not judged to be a serious threat to MANCOVA (Tabachnick & Fidell, 1983).

As MANCOVA is highly sensitive to outliers, each cell of the design was checked for univariate and multivariate outliers (Tabachnick & Fidell, 1983). This resulted in four cases being identified as multivariate outliers and omitted from further analysis. This left cellwise *n*s of 28, 27, 28, and 23, respectively (outlying cases omitted from the MANCOVA are described in Appendix M).

Tabachnick and Fidell (1983) note that homogeneity of variance of each of the dependent variables as well as homogeneity of the variance-covariance matrices are assumptions of MANCOVA that must be met. As Verbal Recall was positively skewed, a transformation by the square root reciprocal (by a value of -.5) was attempted but, as this did not yield better behavior on subsequent tests of assumptions, Verbal Recall was left untransformed. In its untransformed state, the Levene statistic, which tests homogeneity of variance, did not reach criterion, indicating that the homogeneity of variance assumption was not violated for the verbal facts recalled (Levene statistic (3, 106) = 1.73; $p = .17$). Plots of observed and predicted values, of predicted and residual values, normal plots of residuals, and detrended normal plots were generated and examined for evidence of multivariate normality and homogeneity of variance of dependent variables. While those plots for Verbal Recall were only marginally acceptable, those for the other dependent variables were judged adequate. In addition, *Box's M*, a multivariate test of homogeneity of the covariance matrices, indicated that the assumption of homogeneity was not violated; *Box's M* = 38.93; F (30, 27492) = 1.21; $p = .20$.

To check linearity, within-cell scatterplots of all dependent variables and dependent variable-covariate pairs were examined. In each condition, one or more plot did not appear linear. Each nonlinear display involved Verbal Recall or Attention. These plots either exhibited a mildly curvilinear pattern, or a fairly random array. A potential consequence of this might be overly conservative estimates of group differences. Checks for multicollinearity among covariates and dependent variables consistently yielded good results.

The assumption of homogeneity of regression was tested for both the omnibus MANCOVA and the stepdown MANCOVA by creating an interaction term with the covariate *TOLD* and factors and testing its effects (as Attention and Picture Task also functioned as covariates in later steps of the step-down MANCOVA, interaction terms were checked for them as well). The effects of the interaction terms were not statistically reliable for either the omnibus MANCOVA nor the step-down MANCOVA. In the omnibus MANCOVA (with the outliers omitted as described above), the interaction term had a Pillais value of .037, with an approximate F (9, 294) = 0.41; $p = .93$. In the stepdown MANCOVA, the Fs for the interaction term for Attention, Picture Task, and Verbal Recall, respectively, were F (3, 98) = 0.12; $p = .95$; F (3, 97) = 0.47; $p = .71$; and F (3, 96) = 0.63; $p = .60$.

<u>Omnibus MANCOVA</u>

An omnibus MANCOVA, with Pace and Redundancy as two-level independent variables, *TOLD* as the covariate, and Attention, Picture Task, and Verbal Recall as dependent variables was run, with outliers deleted as described earlier. Using the sequential method of entry (with the Cholesky approach to estimation), and Pillais' criterion, the combined dependent variables were reliably related to the covariate *TOLD*, F $(3, 96) = 8.00$; $p \leq .001$, and to Pace, $F\ (3, 96) = 4.35$; $p \leq .01$; but not to Redundancy, $F\ (3, 96) = 0.35$; $p > .05$, or the Pace by Redundancy interaction, $F\ (3, 96) = 2.27$; $p > .05$.

Stepdown MANCOVA

A stepdown analysis was then performed in order to investigate the effects of each main effect and the interaction, adjusted for the covariate *TOLD*, on the individual dependent variables, Attention, Picture Task, and Verbal Recall (see Table 9). Alpha was apportioned as shown in the last column of Table 9 in order to achieve an experimentwise error of 5%.

Table 9
Tests of Pace, Redundancy, and their Interaction, with *TOLD* as a Covariate

Independent Variables	Dependent Variables	Univariate F	df	Stepdown F	df	Alpha
Pace	Attention	8.54***	3/96	8.54***	1/98	.02
	Picture Task	0.41	3/96	1.58	1/97	.02
	Verbal Recall	2.17	3/96	2.69	1/96	.01
Redundancy	Attention	0.44	3/96	0.44	1/98	.02
	Picture Task	0.33	3/96	0.53	1/97	.02
	Verbal Recall	0.16	3/96	0.09	1/96	.01
Pace by Redundancy	Attention	1.53	3/96	1.53	1/98	.02
	Picture Task	6.21***	3/96	5.04*	1/97	.02
	Verbal Recall	2.11	3/96	0.22	1/96	.01

Note. * $p \leq .05$; ** $p \leq .02$; *** $p \leq .01$

As can be seen, Attention, adjusted for the covariate *TOLD*, is related to Pace, stepdown $F\ (1, 98) = 8.54$; $p \leq .01; \eta^2 = 0.08$. As discussed in the path analysis section, students in fast-paced instructional language conditions paid greater visual attention to the instructor during the lesson, and attention was reduced in the slow-paced conditions. While Redundancy does not have a main effect on any of the dependent variables, once the pattern of differences measured by Attention was entered, there was a Pace by Redundancy interaction effect on Picture Task, stepdown $F\ (1, 97) = 5.04$; $p \leq .05$; $\eta^2 = 0.05$. As shown previously in the causal models for fast-paced and slow-paced conditions, more redundant instructional language has a statistically reliable positive effect on learning as measured by the Picture Task for students who heard fast-paced instructional language, but not for those who heard slow-paced instructional language.

Qualitative Profiles of Selected Participants

The preceding quantitative results provide a brief and numerical summary of 120 primary students' performance on various theoretically related tasks. But the numbers alone are not a substitute for seeing and hearing what real students individually said and did as they engaged in various group and individual activities that involved learning about chipmunks. As the researcher, I was present participating in and observing all of these events. I talked to these students' teachers, and subsequently, I spent many hours viewing videotapes, listening to audiotapes, scoring language tests and picture tasks, and reading through information provided by the teachers. Thus, the discussion and interpretation of results in the chapter to follow rest both on the statistical analyses, and on the more holistic, qualitative understandings I developed through my role as observer and researcher. This brief description of four students, then, is intended to give a "flavour" of the events, tasks, and individuals engaged in them, and to hint at how this qualitative and the previously described quantitative information interactively inform and extend each other.

In this section, I describe four students, drawing on the videotaped, audiotaped, and "pencil and paper" data collected. Two of the students obtained mean *TOLD* scores, one scored one and a half standard deviations above the mean on the *TOLD*, and one scored one and a half standard deviations below the mean. In addition, each of the four students participated in a different instructional language condition.

Geoffrey

"Geoffrey" was a boy in grade 2 who was 7 years, 6 months old. Geoffrey's *TOLD* score of 18 was at the mean for the study sample of 120 students. Geoffrey attended a small school in a largely middle class area of single family dwellings, and also including a trailer park and some small older houses in its catchment area. Geoffrey was enrolled in a grade 2-3 combined class, and his teacher described him as having high language ability, and no special learning needs.

Geoffrey was randomly assigned to a lesson presented fast and nonredundantly. His group of two girls and four boys demonstrated below average attention to the chipmunk lesson. Average percent attention in this condition across all participants was 70.1, but Geoffrey's peers averaged 57 percent attention. Geoffrey, however, attended for only 42 percent of the lesson. During the lesson, Geoffrey moved about, made silly noises, giggled, and poked and talked to other students. He appeared to be a "ring leader" in this situation. Nevertheless, on the Picture Task immediately following the lesson, Geoffrey obtained a score of 6, which was above the mean Picture Task score of 5.3 obtained in Condition 1.

In the next activity, the discussion group, Geoffrey seemed eager to talk but, perhaps concerned that he might say something about chipmunks that was incorrect, he tended to repeat comments that others had made rather than introduce new points. Next, the students made chipmunk pictures and took turns being interviewed individually (Verbal Protocol and Metapragmatic Probe). These interviews were conducted across the room from where the students coloured pictures at a table. Under this condition of less direct supervision, Geoffrey took the opportunity to engage in disruptive behaviors such as grabbing markers away from others and making loud, rude comments. I had to intervene more than once. However, as the interviews proceeded, Geoffrey appeared to realize that he would soon be called upon to explain what he knew about chipmunks. He then sat quietly, looking in the direction of the interviews, perhaps straining to hear what other students said about chipmunks.

When it was Geoffrey's turn to be interviewed, he began by making noises and "silly" remarks into the tape recorder. However, after I verbally redirected him, he readily engaged in the task at hand, and talked at length about chipmunks. His Verbal Recall score of 9 was above the average of 6 for Condition 1. In the Metapragmatic Probe portion of the interview, Geoffrey said that he thought I had presented the lesson at a medium pace without repeating much, that the lesson was easy to understand, and that I spoke clearly. He commented that the lesson was too long. Of all of the activities to do with chipmunks, Geoffrey said he thought the "pretend scientist's" lesson helped him learn the most about chipmunks.

Jonie

"Jonie" was a girl aged six years, four months, and enrolled in grade 1 in a combined grade 1-2 class. She was the youngest participant in the study. Like Geoffrey, Jonie obtained a *TOLD* score of 18, right at the mean for this sample. She also attended the same school as Geoffrey. Her teacher described her as having average language ability and no special learning needs.

Jonie was assigned to a slow nonredundant lesson. Jonie was highly attentive during the lesson, gazing at me in my role of "chipmunk scientist" 84 percent of the time. This was one standard deviation above the mean percent attention of 66.4 overall for students in this condition. Jonie also paid more attention to the lesson than other students in her group (three girls and two boys), who averaged 67 percent attention. Despite Jonie's attention to the lesson, on the subsequent Picture Task, she obtained a score of only 3, which was 1.9 standard deviations below the mean of 6.8 achieved by Condition 3 participants.

In this discussion group, all of the children, including Jonie, seemed unsure about how to proceed. They did make several spontaneous points about "chipmunks' dinner time," and each readily commented when subsequently prompted by the researcher to talk about other chipmunk topics. Overall, Jonie presented as a "quiet" member of the group. This was also observed during colouring, as Jonie quietly attended to the task at hand.

In the individual interview, Jonie readily reported eight "facts" about chipmunks (an average Verbal Recall score for this condition), such as "the girl chipmunk and the boy don't go in the same burrow." She giggled as she described the chipmunks eating "cherries," perhaps recalling the amusement expressed by several children in her group during the lesson, when chipmunks were described as liking "chokecherries." In the Metapragmatic Probe, Jonie said I talked "like a scientist," at a medium pace, and that I hardly repeated at all. She said that the thing that had helped her to understand was that I had "talked clear," but that the lesson would have been better had I talked louder. She said that me reading [the lesson] was what helped her learn the most.

<u>Mika</u>

"Mika" was a boy in grade two aged 7-8 years. Mika's *TOLD* score of 13 was 1.5 standard deviations below the study mean of 17.6. Mika attended a school serving a large mixed area including a large number of low rent apartment buildings as well as a middle class area of single family dwellings. Mika's teacher reported that each year about one third of her class were recent immigrants to Canada, and many were learning English as a second language. Mika's teacher identified him as ESL with low language ability. She questionned whether he might have a learning disability.

Mika was randomly assigned to the slow, redundant condition. His group was also the first to participate in the actual (rather than preliminary) data collection. Of the six students in his group (three boys and three girls), all but one were identified by their teachers as ESL. This was a very active group that seemed to have difficulty understanding what they needed to do during the lesson. We had three false starts prior to the text of the chipmunk lesson, as I needed to stop and reinstruct the students. One girl had particular difficulty remaining seated on the floor, and Mika exchanged loud remarks with the two other boys, and had to be reminded to not handle the floor microphone. In addition, it was a very warm May afternoon in a south facing classroom.

Mika exhibited 43 percent attention to the lesson, which was 1 standard deviation below the mean for this condition. His peers averaged 50.2 percent attention. Mika seemed to be almost constantly in motion during the ten minute lesson.

Mika obtained a Picture Task score of 5, which was average for this condition. However, vigilance on my part was necessary, as he seemed determined to copy his peers' responses to the task. In the discussion group that followed, the participants spent three minutes arguing about who ought to talk first and "fooling around," and little was said about chipmunks. However, when I subsequently prompted them to talk about each topic, the students were able to accurately describe several characteristics about chipmunks and their habitat. Although Mika was quick to talk in this situation involving some adult direction, his remarks tended to be off-topic or difficult to interpret.

The drawing activity provided Mika another opportunity to move about getting markers and paper, and his talking and "off-task" activities escalated. He did produce a picture, however. In the individual interview, Mika obtained a Verbal Recall score of 3, within average range for this condition. His few accurate points about chipmunks (like: "and the mother, she doesn't like anybody touch their baby") were mixed with vague generalities ("they carry food"), and misconceptions ("When they're in danger, they swim").

In the Metapragmatic probe, Mika described my way of talking as "like a scientist," and said that what made the lesson easy was that I "repeated things - the words." Several of his responses, however, suggested that he had not understood the question I had asked.

<u>Randy</u>

The final particpant to be profiled here is "Randy," a boy age 8-5 in grade two (in a grade two/three combined class). Randy's *TOLD* score was 22, 1.5 standard deviations above the study mean. He attended a large school bordering a major commercial area. Housing was a mix of apartments, townhouses, and smaller, older houses. Randy was identified as having low language ability and no special learning needs. To this researcher, Randy presented as very talkative, and adult-identified rather than tending to interact with his peers.

Randy was in the fast-paced, redundant instructional language condition. During the lesson, Randy exhibited 66 percent attention, slightly below the mean of 73.8 for this condition, and below his five peers' average attention of 76.9. In this group of three boys and three girls, two of the girls interacted a little during the lesson, but the other students sat quietly, by and large. Randy spent considerable time gazing around the resource room.

Randy's Picture Task score of 9 was slightly above the mean of 6.7 for this condition. The students in this group appeared to be quite uncomfortable discussing chipmunks among themselves, and mostly sat quietly, whispering and glancing at the video camera, until the researcher provided topic prompts. When prompted, the students were able to make accurate statements about chipmunks. Randy was especially eager to participate in this researcher-directed discussion, and he offered several "answers."

Randy's Verbal Recall score of 11 was again slightly above the mean of 7.8. He readily launched into a description of chipmunks and their habitat, without needing any prompting in this situation. However, when asked questions about my style of talking during the lesson, and his opinions about what was hard and easy and so forth, he dropped to one-word responses, or said "I don't know." He did say that I could have made the lesson better by making it a little bit harder.

These four students profiled were selected on the basis of their *TOLD* scores, rather than as prototypical examples, or exemplary cases. It is hoped that this brief description has provided a feeling for the variety of students participating, some of the contextual aspects of the schools, activities, and so on, the social roles played by the peer groups, and the roles of the researcher in all of this.

Results Summarized in Terms of Initial Research Questions

In this section, I revisit the original research questions presented in the introduction, and briefly report the findings as related to these questions.

1. Throughout the analysis, results consistently showed that Language ability/English language proficiency as measured by the *TOLD* subtest of receptive vocabulary or by teachers' judgments was strongly related to students' outcome performances following the chipmunk lesson.

2. Slower pace of presentation was related to higher outcome scores, regardless of students' initial language levels, especially on the multiple-choice picture task. Students with special learning needs who heard slow-paced instructional language tended perform less well on outcome tasks than those who heard fast-paced instruction. Special needs learners performed similarly to regular peers in fast-paced conditions, but much below regular peers in slow-paced conditions, especially on verbal recall.

3. Redundancy did not have a main effect in explaining learning outcome, but there was a reliable interaction with pace.

4. In fast-paced instructional language conditions, adding redundancies corresponded with higher picture task scores, but redundancy did not play an explanatory role overall in slow-paced conditions. When regular and special needs learners were examined separately, it is clear that regular students' verbal recall performance was best when they had heard slow redundant instructional language, whereas special needs students' obtained their lowest verbal recall scores in the slow redundant condition.

5. Students' attention to the chipmunk lesson was explained by both pace of the instructional language, and the amount of attention paid to the lesson by other students in

the same group. Students attended more to fast-paced instruction, and when their peers paid attention. Language ability did not correspond to attention. Students with special needs attended to fast-paced instruction as much as their regular peers, but were much less likely to attend to slow-paced or redundant presentations.

6. Attention was found to mediate between language ability and pace and redundancy of instructional language on the one hand, and learning outcomes on the other. While both attention and slow pace corresponded to better learning outcomes, students tended to pay less attention to slow-paced instruction. For regular students, the decrease in attention to slower, more redundant instructional language was slight, not enough to offset the substantial learning outcome gains. But for special needs learners, the decrease in attention was considerable, and was matched by a corresponding decrease in learning outcome scores.

CHAPTER V

DISCUSSION

This chapter consists of several sections. First I examine the results of the test of the theorized causal model and comment on the extent to which the postulated causal relationships are supported by the findings of this study. The mediating role of attention is reviewed and discussed. One of the most interesting findings of the study is then presented in a section on the ways in which learners identified as having special needs responded to the learning tasks as compared with the performance of teacher-identified "regular" learners. Reasons for these differences are considered. Then other influences on participants' learning, including the role of sex and the role of peers' attention are discussed. The discussion then moves to a consideration of the theoretical and instructional implications of this research. Limitations of the study are discussed, and some wider conceptual and methodological questions about approaches to inquiry in classroom interaction are raised. The chapter concludes with a brief comment on directions for future research.

Support for Theorized Causal Relationships

This study was designed to test a model of communicative interaction in an instructional context, and to examine the causal effects of varying properties of instructional language on students' learning outcomes. Learning was conceptualized as a function of what learners brought to the learning situation, what the instructor brought, and what happened during the learning time. Environmental or contextual influences (aside from those directly attributable to teachers' communicative acts) were seen as a fourth category of important variables.

Language Level and Learning Outcome

It is clear that learners come to any learning situation with both expectations and "a history." What learners bring to a situation include expectations, motivations, emotions, dispositions, domain-specific content knowledge, learning and thinking skills and strategies, and language knowledge and skills. All of these, in combination, influence whether and how any particular individual will engage in a learning situation, and what he or she will learn from that experience. In previous chapters, I have argued that a learner's language knowledge and skills are especially important determinants of engagement in and learning that accrues from classroom instruction. Therefore, this study focused on language knowledge and skills rather than other aspects of learners.

It is difficult to describe in a comprehensive way exactly what constitutes a person's language knowledge and skills. Taking a traditional linguistic approach, we might describe language as having the components of syntax, morphology, semantics, and phonology (Fromkin & Rodman, 1974; Liles, 1975). A somewhat more recent view would add the component of pragmatics, or language use (Bloom & Lahey, 1978; Prutting, 1982; Prutting & Kirchner, 1987; Roth & Spekman, 1984a, 1984b). Others distinguish between comprehension and production, and argue that what one says is but an imperfect reflection of what one linguistically knows (reviewed in Lahey, 1988). The extent to which language determines thought or is separable from thought is debated (Vygotsky, 1962). Still others focus on communicative role, and differentiate between reception and expression, or focus on both communicative role and communicative channel, and specify four aspects, -- reception of spoken and written language (i.e., listening and reading) and spoken and written expression (i.e., speaking and writing) (DeStephano, 1978; Martlew, 1986). The extent to which language knowledge overlaps with or can be separated from the complex of knowledge and skills described as "speech," and the dynamic social events and processes denoted by "communication" is also debated (Miller, Yoder, & Schiefelbusch, 1983; Schiefelbusch & Lloyd, 1974).

The point is that language is complex and hard to characterize in a simple and straightforward way. Those who are called upon to assess individuals' language knowledge and skills in practical settings, such as speech-language pathologists and classroom teachers, tend to rely both on batteries of tests that measure many aspects of language and on observations across many situations and over time. Often just a particular aspect of language knowledge or skill that is judged particularly relevant to a situation at hand is observed and measured (i.e., a teacher might assess reading comprehension). In this study, the primary learning task involved listening, thus reception of spoken language was judged to be the relevant aspect of language ability under consideration. A measure of receptive vocabulary (*TOLD* subtest) was used as a proxy for language ability or English language proficiency. This was supplemented with students' teachers' global ratings of language ability. These two English language ability indicators were found to be highly correlated.

In the path analysis testing the a priori theoretical model, the *TOLD* score was reliably correlated with both learning outcome measures: the multiple-choice Picture Task and the free Verbal Recall measure. The results of the omnibus MANCOVA also showed *TOLD* to be related to the combined dependent variables (Attention, Picture Task and Verbal Recall) at a highly statistically reliable level. These findings support the hypothesis that language ability or English language profiency explains some of the variance in these students' learning from expository instruction. Three variables, *TOLD*, pace of instructional language, and students' attention to the lesson, accounted for 26 percent of the variance in Picture Task in the theory-trimmed path model (Figure 9). *TOLD*, Pace, Attention, and Picture Task accounted for 22 percent of the variance in Verbal Recall in the theory-trimmed model.

Clearly, not all of the variance in learning outcome was explained, but this is not surprising given that several aspects of individual differences of learners were not included as variables in the model. Several such individual differences of learners, such as sex, age, grade, special needs designation, and prior knowledge of chipmunks were examined outside the model and , if indicated, included in alternative path models in an attempt to avoid mispecifying the path model through omission of major explanatory variables.

These investigations supported the decision to omit most of these variables, except Sex and Special Needs, for which alternative path models were developed. For other potentially relevant individual differences of learners, data were not collected or explicitly examined. Given the proportion of variance not explained, it is likely that some of these other individual differences would be reliably related to learning outcomes and ought to be considered for inclusion in future tests of this explanatory model of learning.

Despite the omission of potentially relevant explanatory individual difference variables, and even with the use of a relatively narrow and crude language ability indicator (rather than a comprehensive clinical language assessment), these results clearly support the initial hypothesis that language ability (or, for the ESL learners, English language proficiency) explains a significant part of the variance in these students' learning outcomes.

Instructional Language and Learning Outcome

Just as characteristics of learners influence what students learn, characteristics of teachers and their instruction were hypothesized to influence students' outcomes. There are many ways in which teachers' personal characteristics and the instruction they deliver can vary. As the focus here was the role of language in learning, I examined the effect of two instructional language variables, pace of speaking and redundancy of key ideas, on learning outcome.

As argued earlier, these aspects of instructional language were not chosen arbitrarily, but, rather, because of their theoretically key influence on complexity or difficulty of the lesson. The students' task during the chipmunk lesson was to listen. As no information about chipmunks was presented visually or through other means during the lesson, the only immediate source of new information about chipmunks was the instructor's spoken language. If we accept the premises of an information processing model of knowledge construction and memory (Farnham-Diggory, 1992; Klatzky, 1975; Mayer, 1987), it is clear that increasing the pace of presentation of information correspondingly reduces the amount of time that each "piece" of information is available in working memory. Amount of time available for processing the information for transfer to long term memory is reduced. Alternatively, amount of time in working memory is unchanged, but the number of pieces that are accepted into working memory for processing are fewer than if information is presented more slowly. Therefore, if the lesson content is appropriately challenging, pace of instructional language ought to be inversely proportional to learning outcomes (assuming that there are no other mediating variables).[1] Similarly, redundancy of key ideas in the lesson would be expected to increase the amount of time an idea is available in working memory, and thus positively correlate with learning outcome.

Ignoring Attention for the moment, we find support for the predicted relationship between Pace and Picture Task at a statistically reliable level (Figures 8 & 9). Faster paced instruction negatively affected learning outcome, and slower instructional language resulted in higher learning outcomes. The relationship between Redundancy and Picture Task was also in the direction predicted, but not at a statistically reliable level (Figure 8). However, in the alternative model including only fast-paced instructional language conditions, Redundancy showed the predicted effect on Picture Task at a statistically reliable level. This suggests that redundancy was important for learning in lessons made more challenging by increasing pace (Figure 11).

The direct effects of Pace and Redundancy on Verbal Recall were in the direction predicted, but not at a statistically reliable level. The intervention of several instructional events between the chipmunk lesson and the verbal recall task, including the picture task, the group discussion, and the colouring activity, probably mitigated a strong direct effect.

1This argument about pace and working memory rests on the assumption that pieces of incoming information can be processed in turn, as contrasted with a situation where the incoming information is interdependent. When several pieces are needed to make sense of any one piece, pace would need to be fast enough ensure all the pieces would be available simultaneously. Because of the duration constraint of short term memory, excessively slow pace results in diminishing returns.

The findings of the omnibus MANCOVA support a similar interpretation of the relationship between instructional language and learning outcomes. Pace was related to the set of dependent variables (Attention, Picture Task and Verbal Recall) at a statistically reliable level, but neither Redundancy nor the Pace by Redundancy interaction were reliably related to the set of dependent variables. However, in the stepdown MANCOVA, with *TOLD* as a covariate, a somewhat different picture emerged. Pace was reliably related to Attention, but not to Picture Task or Verbal Recall. A reason for not finding a reliable main effect of Pace on Picture Task will be offered below in the section discussing the mediating role of attention. As in the a priori path model, Redundancy did not correlate with any of the dependent variables. The Pace by Redundancy interaction was reliably related to Picture Task score, but not to Attention or Verbal Recall. This statistically reliable interaction supports the earlier finding about the important role that increased redundancy played for those students who heard fast-paced instructional language.

Overall, these findings about the relationships between instructional language and learning outcomes provide support for the role of pace of instructional language on students' learning as reflected by Attention and Picture Task. The theorized influence of redundancy of instructional language on learning received conditional support; that is, adding redundancies was helpful in fast-paced instruction, but not in slow-paced instruction.

<u>The Mediating Role of Attention</u>

Up to this point, I have discussed the causal model as if assuming that participants' language ability and the instructor's instructional language somehow directly influenced learning outcome, without being mediated by what happened during the instruction. This, I think, has been a common misleading assumption in process-product research, and one that has been only partly remediated by ethnographic and sociolinguistic observational studies of classroom processes. As I have argued in previous chapters and elsewhere

(Lapadat, 1991b, 1992), while process-product researchers searching for influences on learning outcomes have often failed to develop research designs that examine what actually happens in classrooms, classroom process researchers have gathered important information about the complexity of events and interaction occurring in classrooms but have failed to make strong links between these findings and their academic effects (see also Carlsen, 1991; Winne, 1987).

In real classrooms or other instructional settings (i.e., speech therapy offices or resource rooms), teaching and learning do not take place in the static way implied by research designs that involve relating one or two indicators of teachers' prior characteristics or acts with one or two indicators of subsequent learning outcomes. As is shown so clearly in descriptive studies by Erickson (1982) and Green and Harker (1982), for example, instructional and learning events are complex, dynamic, and interactive. Process-product designs could, therefore, be enriched through the inclusion of variables that more accurately track or represent what actually happens during instruction or learning.

What happens during instruction can be conceptualized as including both internal cognitive events or processes and external events or processes. Processes at both of these levels mediate the influence of instructional design variables (e.g., use of advance organizers) or teacher characteristics (e.g., teacher warmth) on subsequent learning outcomes. Cognitive mediation is difficult to examine, of course, because we have no direct way to look into someone's mind. Methodologies include using a "talk-aloud" protocol, or pencil and paper trace (cf. Howard, 1989; Marx, Winne, & Walsh, 1985), interviewing participants after the instructional event or intervention (cf. Martin & Stelmaczonek, 1988; Martin, Paivio, & Labadie, 1990), or inferring intervening cognitive processes from analysis of performance on various instructional tasks (cf. Seifert, 1991).

On the other hand, while external events or processes can be observed and recorded, and often certain parts can be measured, issues like perspective, inclusiveness, summarization, and interpretation can be extremely problematic (Evertson & Green, 1986). For example, with six students working with an unfamiliar instructor/researcher in a resource room as in this study, external variables would include: characteristics of the setting (static), movement around in the room (dynamic), the task or tasks at hand (dynamic), materials being used (dynamic), each student's verbal and nonverbal interactions with each other student (dynamic), students' verbal and nonverbal interactions with the instructor and instructor with students (dynamic), social role (mostly static), communicative role (dynamic), each participants' physical acts (dynamic), and intruding external events (e.g., the bell ringing).

Furthermore, while each participant acts upon and is influenced by other participants, objects, and events in the situation, each of these external variables also can influence and be influenced by each participant's cognitive processes and cognitive structures (knowledge) on a moment-by-moment basis. When learning takes place in the actual instructional situation it is extremely difficult to model or summarize succinctly.

The nature of attention. The mediational variable of greatest interest in the test of the theoretical model was participants' engagement in the task of learning by listening to the chipmunk lesson. For the duration of the chipmunk lesson, many of the external variables were held relatively constant. Communicative interaction was constrained by using an expository approach to instruction involving a unidirectional flow of information. As the information about chipmunks being presented was new, for the most part, and quite complex, and as participants knew that they would later have a turn "being the chipmunk scientist," I expected that they would need to attend to the lesson in order to do well on subsequent tasks, and that they would be motivated to do so. As the task involved listening, attention to the lesson reflected engagement.

Attention can be seen as involving one or more internal cognitive processes. As discussed in Chapter II, within an information processing model, attentional processes influence what information enters sensory memory, and what information from sensory memory then enters short term memory and thence, potentially, long term memory stores. In this study, a participant who had momentarily turned her gaze to the child next to her in order to listen to what that child was whispering could be described as "not attending" in the sense that the auditory and visual images carrying the content of the lesson were no longer entering her sensory memory, and therefore the ideas were not being thought about or learned. If a another child was attending to the degree that auditory and visual images of the instructor talking entered sensory memory, but then began contemplating the blister on his thumb, lesson information probably did not reach short term memory or was not acted upon once in short term memory. That participant also could be described as "not attending." In either case, if information was fleeting and redundancies were not provided, specific "bits" of information would have little chance of becoming encoded in long term memory or "learned."

Attention, in this situation, could be defined as participants' reception of ideas from the lesson and their thinking about those ideas. (It is not assumed that the participants necessarily received the same ideas that the instructor intended.) These internal attentional processes might have external correlates, such as, direction of eye gaze, body posture, facial expression, and engagement in other activities. These external attentional behaviors serve as both an (imperfect) indicator of internal cognitive processes, and as a contribution to the flow of events happening during instruction. For example, if a participant takes a small toy out of his pocket and whispers to his neighbour about it while other children in the group begin to look on, that boy is not only not engaged in the listening task (not attending to the incoming bits of information), but also is influencing other participants' engagement (attention). Exactly this kind of effect was observed, which led to developing an alternative path model with a variable representing peer attention, which will be discussed in a subsequent section.

Attention and learning outcome. In keeping with an information processing model of learning, I had expected that students who paid more attention to the lesson, as indicated by eye gaze at the instructor, would also learn more. This hypothesis was supported. Attention had a highly reliable positive effect on Picture Task. The effect of Attention on Verbal Recall was in a positive direction, although not statistically reliable. In addition, there was an indirect positive effect of Attention on Verbal Recall conditional on Picture Task.

Language ability/proficiency and attention. In this kind of very structured expository instruction, what influences whether or not students will pay attention? I had anticipated two possibilities. Ability or proficiency at receptive listening tasks (in English) seemed likely to explain attention, in part. I also expected that that characteristics of the instructional language would influence attention.

While I thought language ability or proficiency would be explanatory, I thought the relationship might not be straightforward. For example, I theorized that highly linguistically competent students might be that way because, for whatever reasons, they had developed a strategy of paying attention to spoken language, while less linguistically able students might not have that strategy. On the other hand, I thought that perhaps students assess how much attention they feel is needed for any particular task, and that students who perceive a task as easy would allocate less attention to it than those who perceive it as hard. I assumed that students who have strong language skills would be more likely to perceive this listening task as easy, and thus allocate less attention to it, than students with less developed language skills. In these two possible explanations, the relationship between *TOLD* and Attention would have opposite directions.

In fact, the findings of this study did not support a relationship between language ability or proficiency (as indicated by the *TOLD* score) and Attention. *TOLD* did not have a statistically reliable effect on Attention in the test of the theoretical causal model, nor in any of the alternative path models. In speculating on the reason for this lack of support, it might be erroneous to assume that language ability and attention are related. Or, the methodology of this study could be at fault. For example, *TOLD* could be an inadequate proxy for language ability or English language proficiency, and, similarly, percent of visual attention to the instructor could be an inadequate proxy for attentional processes. Finally, the participants in this study could have had different reasons for paying attention or not paying attention, and effectively cancelled each other out; that is, both of the two explanations posited could be simultaneously in effect for different students (however, the data were normally distributed, suggesting one population rather than two).

Instructional language and attention. I also expected, beforehand, that aspects of instructional language would influence attention. The two aspects of instructional language examined in this study, pace and redundancy, have a direct effect on the complexity of the information processing task facing the listener. In terms of an information processing model, when the flow of new information exactly matches a listener's processing rate, that learner would need to devote full attention to listening in order to make meaning out of all parts of the lesson. This assumes a uniform processing rate for any individual for a given collection of information about a topic, however, which is simplistic. For example, it might take a listener much longer to make meaning of one unfamiliar word than 20 familiar ones. Processing rate cannot be assumed to be equivalent across individuals, either. In this listening task, participants might be expected to differ in prior knowledge about chipmunks, linguistic ability, familiarity with this type of listening task, and efficiency of their cognitive strategies, all of which might influence average processing speed. Furthermore, individuals' motives, dispositions, and past experiences would be expected to influence how they interpret the task at hand, and whether they consider it worthy of undivided attention.

When the the pace of the lesson exceeds the listener's processing rate, there are two possible consequences. Either, bits of information will be edged out of short term memory by new incoming information before the listener has had time to act upon them and integrate them with existing knowledge; or, while the listener is processing a bit of information he or she will not attend to other incoming new information and it will not register. Some children might then perceive the task as too hard, and simply "give up" on the listening task, whereas others might be challenged to listen harder (pay more attention; process the information more efficiently). Again, the discrepancy between pace and processing time would be expected to vary across participants. It is possible that for one student, the slow-paced lesson could slightly exceed his processing rate, while for another the fast-paced lesson could be grasped at that rate with time to spare.

Finally, there is the situation in which the relationship between pace and processing speed is such that students need only allocate their attention to listening part of the time in order to fully process all of the information presented. For many of the participants, the slow-paced condition was expected to produce decreased attention for that reason, while for some others, it was expected that the slow pace would match their processing rate (and thus yield high attention).

The addition of redundancies (defined as the repetition of key ideas) was expected to have the effect of reducing the complexity of the incoming message. It was expected to interact with pace and with students' existing processing capability to influence participants' level of attention and learning outcomes. For example, in the situation in which pace exceeded processing speed, adding redundancies would give listeners another chance to consider that bit of information, and thus slow down the rate at which they needed to process information overall. This might increase the amount of attention allocated to listening for those participants who might have otherwise perceived the task as too difficult and given up.

My study showed dramatic effects of one of the instructional language conditions on attention. Slower paced instruction resulted in less attention to the chipmunk lesson, and faster paced instruction led to greater attention, at statistically reliable levels. This effect was found in both the causal models and in the stepdown MANCOVA. On the other hand, redundancy did not reliably influence attention in any of the models tested. These results show that the primary program participants in this study attended more closely to the chipmunk lesson when it was fast-paced than when it was slow-paced, but that level of redundancy did not affect attention.

Attention as a mediator. Thus, attention was influenced by pace, and pace, attention, and sometimes redundancy influenced the picture task learning outcome. Attention did not mediate the influence of *TOLD* on learning outcomes.

However, this mediational role is more complex than it first appears. Increasing pace of instructional language increased participants' attention to the lesson, as predicted by the information processing model. Presumably, increasing pace increased the complexity of the information processing task, so participants allocated more attention to listening when I talked fast and less when I talked slow. (This effect is shown in the path models as the path from Pace to Attention.) However, a high level of attention produced relatively more learning than low attention (shown in the path from Attention to Picture Task), suggesting that the listening task was complex enough that participants needed to allocate plenty of attention to listening in order to learn facts about chipmunks. And, furthermore, slowing the pace of the instructional language was shown to have a statistically reliable positive direct effect on Picture Task (shown in the path from Pace to Picture Task), a finding which is also consistent with predictions of an information processing model. That is, slowing the rate of flow of new information helped participants learn facts about chipmunks, regardless of attentional variations. At the same time, many students were less likely to pay attention to slower paced instruction, and those students learned less from the slow-paced instruction than students who paid attention.

How do we interpret these contradictory effects of Pace on Picture Task via Attention, as compared to its direct effects? One thing that seems clear is that even in the slow-paced language conditions, the listening task was sufficiently difficult that participants were only able to remember about half of the 12 key facts about chipmunks in the picture task (an average of 6.8 facts in the slow, nonredundant condition, and 6.1 facts in the slow redundant condition). Similarly, participants in the slow conditions only mentioned 7.8 and 7.3 facts about chipmunks respectively in the free verbal recall task (out of a possible maximum of about 138 different lesson facts). So why did the participants in the slow conditions pay less attention, given that they had only learned part of the information? Did they misjudge the level of challenge, assuming the task to be easy because pace was slow, even though the task was not easy? Did they learn all the information and then forget it or fail to retrieve it during the learning outcome measures? Did they find it easy to understand what I said, and therefore reduce their level of attention, while at the same time failing to act upon the information they had heard in order to retain it in long term memory? Or, is there a threshold for speaking rate below which listening simply becomes tedious, no matter how helpful that pace might be for learning? On the other hand, perhaps these conflicting results reflect that different learning processes were taking place for different subsets of the participants.

This last possibility can be investigated by examining some of the alternative path models generated for subgroups of participants. When we look at the separate path models by condition (Figure 10), or the path models for fast and slow conditions (Figure 11), it is clear that Attention played a different role depending on pace of instructional language. In the fast-paced conditions, paying attention was very predictive of learning outcome as measured by Picture Task, and Picture Task score, in turn, predicted Verbal Recall. In addition, redundant instructional language was related to higher Picture Task scores, which were then related to higher Verbal Recall scores. Together with *TOLD*, Attention and Redundancy accounted for close to half of the variance in Picture Task. In other words, when fast-paced instructional language was presented, learning depended on having good language ability or English language proficiency, paying attention, and hearing some repetitions of key ideas.

But in the slow-paced conditions, neither Attention nor Redundancy had statistically reliable effects on Picture Task or Verbal Recall. *TOLD* alone predicted Picture Task, and 84 percent of the variance was left unexplained. One possible explanation is that students were better able to process slower paced information, but because the participants chose to pay less attention to slower-paced instructional language, these two opposite effects statistically cancelled each other out. This might also help to explain why, in the stepdown MANCOVA, Pace adjusted for the covariates *TOLD* and Attention did not have a statistically reliable effect on Picture Task.

Overall, mean scores on both Picture Task and Verbal Recall indicate that students who heard either fast, redundant instructional language or slow, nonredundant instructional language learned the most about chipmunks. Students who heard slow, redundant instructional language learned somewhat less, and students who heard fast, nonredundant condition learned the least (Table 3). In information processing terms, the "easiest" condition (slow, redundant instructional language) did not yield the best learning outcome, although the "hardest" condition (fast, nonredundant instructional language) did result in the least learning even though these students displayed high levels of attention. (Different patterns were apparent when regular and special needs learners were examined separately, as discussed subsequently.)

Examination of three other variables that showed a statistically reliable effect on attention, special learning needs, peers' level of attention, and sex, also explain some of the complexities of the mediational role of attention. These will be discussed in a subsequent section.

Context

Earlier, I suggested that contextual or environmental variables are important influences on what happens during learning situations, and on learning outcomes. Yet, the only contextual variables built into the theoretical model I tested were pace and redundancy of instructional language. The reason for this is that, as learning environments are exceedingly complex, an attempt to causally model contextual influences comprehensively would require many variables. Even if I limited my focus to external variables, the model would still likely be seriously misspecified because of the difficulty of characterizing the dynamic, diachronic aspect of classroom interaction. And even if the model was adequately specified, there would still be more variables than can be managed by multivariate statistical techniques, and meaningfully interpreted.

Therefore, in this design, I attempted to adjust for contextual effects by hypothesizing what those variables might be and, insofar as it was possible, holding those elements constant or allowing them to vary randomly (rather than systematically). Thus, I randomly assigned participants from each school to conditions. I used a lesson script and task instruction scripts throughout. I used the same sequence of tasks and procedures, and so on, as previously described in the Methods chapter. These were attempts to reduce or equate the influence of unstudied contextual variables on learning processes and outcomes.

In the end, though, the causal model was misspecified. Only 5 percent of the variance in Attention, 26 percent of the variance in Picture Task, and 22 percent of the variance in Verbal Recall were explained in the theory-trimmed a priori model. Clearly, some causal variables were missing. The addition of a context variable representing peers' attention to the lesson explained an additional 12 percent of the variance in Attention. Peer Attention, along with an individual difference variable indicative of special learning needs, explained an additional 8 percent of the variance in Verbal Recall. Yet, not only did the model remain misspecified, but in adding those variables post hoc, one must expect some shrinkage when the model is tested on a new sample from whom the variables were not derived. The question is, does what happens during learning from expository instruction consist of such complex interactions of so many contextual and individual difference variables that it cannot be modelled using current statistical tools, or did I just miss a couple of important variables? On the other hand, while these results are neither complete nor unassailable, they are useful, nevertheless.

Differences Between Special Needs and Regular Learners

In my discussion of the mediational role of attention, I commented that perhaps the contradictory effects of slowing the pace of instructional language (slower pace aids learning but slower pace also reduces attention which correspondingly reduces learning) reflects differential responses of subsets of participants. Language ability or proficiency did not reliably explain differences in attention. However, when a variable reflecting identification of students as having a special learning need was included in an alternative path model, Special Needs had statistically detectable direct effects on *TOLD*, Attention, and Verbal Recall. This showed that participants' attention to the chipmunk lesson, as well as their performance on the verbal recall task, differed depending on whether they had special learning needs. Effect size calculations showed that Special Needs students' mean scores were at least half a standard deviation below those of their Regular peers on each of the *TOLD*, Attention, Picture Task and Verbal Recall measures.

To examine the explanatory role of Special Needs more closely, I graphed scores on the *TOLD*, Attention, Picture Task, and Verbal Recall for Special Needs and Regular students by instructional language condition (Gifted students were omitted because there were only 3) (see Figures 4, 5, 6, & 7). Special Needs students in every condition had lower *TOLD* scores, on average, indicating lower language ability or proficiency, than their Regular peers (Figure 4). This discrepancy did not differ by condition, except that Special Needs students in the fast redundant condition scored slightly higher on the *TOLD* than Special Needs students in other conditions (but still below their Regular peers in that condition).

Different Patterns of Attention and Performance

However, in comparing Special Needs and Regular students' attention, picture task performance and free verbal recall by condition, interesting differences emerged. As shown in Figure 5, both Special Needs and Regular students' attention to the chipmunk lesson tended to decrease as the pace of instructional language was slowed and redundancies were added (except that Regular students paid more attention to fast, redundant instructional language than fast, nonredundant instructional language). For the Regular students, the difference in their average attention across conditions was small; there was only a ten percent difference in average attention between the condition stimulating the most attention and the condition stimulating the least. But, for the Special Needs students, the difference in attention across conditions was dramatic. While Special Needs students attended to the lesson as much as their Regular peers when they heard fast, nonredundant language, their attention decreased 22 percent to an average of only 47 percent attention in the slow, redundant condition. For every adjustment to instructional language that made the information processing task easier, special needs learners corresponding reduced their level of attention to the listening task.

How did these two subsets of participants fare on the learning outcome tasks? In the multiple-choice Picture Task, Regular students who heard fast, redundant instructional language scored higher than those who heard fast, nonredundant language, while students who heard slow, nonredundant language scored higher, on average, than than students in either of the fast conditions (Figure 6). Picture Task scores dropped off somewhat in the slow, redundant condition, which was also the condition in which Regular students paid the least attention to the lesson. Special Needs students in the two fast-paced instructional language conditions scored as high or nearly as high as their Regular peers on the multiple-choice picture task. These were also the two conditions for which their average attention was within the same range as Regular students. But Special Needs students in the two slow-paced conditions obtained Picture Task scores markedly below those of Regular students in the same conditions. Special Needs students paid the least attention and obtained their lowest Picture Task scores in the slow, redundant condition. Thus, their performance was poorest in the condition that was "easiest" in terms of information processing demands.

The different pattern of performance of Regular and Special Needs students was even more striking in the free verbal recall task (Figure 7). Regular students recalled the least about chipmunks in the fast, redundant condition, which also was the condition involving the most complex information processing task. Regular students who heard fast and redundant, or slow and nonredundant instructional language (that is, one but not both of the simplifying aspects) remembered considerably more facts about chipmunks, while Regular students who heard instructional language that was both slow and redundant remembered the most, -- almost twice as many facts as their Regular peers in condition 1. Thus, the less complex the information processing task was made by varying instructional language parameters, the more Regular students learned about chipmunks as measured by the final learning outcome task. This was in spite of a slight drop-off in their attention to the slower-paced lessons.

In contrast, Special Needs students' performance on the verbal recall task showed the same pattern as their attention to the lesson. As the complexity of the information processing task was reduced, they paid less attention. As they paid less attention, they learned less, as measured by the verbal recall task. Special Needs students in the fast, nonredundant condition recalled the most chipmunk facts, nearly matching the performance of Regular students, for whom this condition produced the least learning. In the slow, redundant condition, in which Regular students learned the most facts about chipmunks, Special Needs students recalled only two facts, on average, in contrast to Regular students' nine. This is three facts less than Special Needs students had been able to remember a few minutes earlier in the multiple-choice picture task.

Deficit in Knowledge or Skills Explanation

There are two main ways to explain why Special Needs and Regular students showed such different patterns of attention to and learning from the chipmunk lessons. I will first present an explanation based on a deficit model perspective (Edwards, 1986;

Lapadat, 1991a; Stark & Wallach, 1982), then I will present an allocation of resources explanation.

One way to explain these differences is to postulate that, when compared to Regular learners, Special Needs students have some form of deficit. Deficits in linguistic knowledge and skills, prior domain-specific knowledge, schematic knowledge, or strategic learning skills could account for the different patterns of attention and performance.

The findings of this study clearly indicate that Special Needs students were less able linguistically (or, less proficient in English), as measured by both the *TOLD* and teachers' language ability ratings, than the Regular students. Yet, these language differences do not adequately account for the differences in attention. Students with language deficits struggling to understand the vocabulary, syntax, discourse structure, and so on of the chipmunk lesson should have found the slow, redundant lesson easiest to follow and thus been most likely to attend in that condition, whereas the instructional language conditions that provided less time for linguistic processing should have resulted in less attention because the task demands were not as well matched to the students' language abilities.

Nor does a linguistic deficit explanation account for differences in performance patterns. A linguistic deficit model would predict that, for students with language difficulties, learning outcome would be inversely related to the linguistic complexity of the task. In fact, exactly the opposite pattern was found (except for picture task outcome in the fast, redundant condition, which was equivalently low for both Special Needs and Regular students).

An argument that perhaps Special Needs students had less prior domain-specific knowledge (that is, experiences with and knowledge about chipmunks and similar animals and their habitat) than Regular students is hypothetical, as I did not collect data about study participants' prior knowledge about chipmunks (although a similar sample of students in the pilot studies demonstrated low prior knowledge of the lesson facts). It is plausible, however, that new residents of Canada might be less knowledgeable about chipmunks and their habitat than other students, or that some Special Needs students might have had fewer opportunities to observe and talk about chipmunks than many of their peers. In any case, the results do not support a content knowledge deficit explanation. Presumably, participants who had little background knowledge about chipmunks would find the task of listening to and deriving meaning from the lesson more difficult than participants with a lot of background knowledge. Thus the linear relationship between increased complexity and increases in both attention and performance for Special Needs students is directly opposite to the pattern that is predicted by a prior knowledge deficit explantion.

A schematic deficit explanation is equally hypothetical, and also not supported by these findings. The argument for this explanation would be as follows. For whatever reasons (cultural or social class background; developmental level), one could hypothesize that many Special Needs students might have had fewer experiences which involve attentatively listening to an authority tell them about a topic. Thus, they would have been less likely than Regular students (who, presumably, would have had these experiences) to have developed a schema for expository instruction. This explanation would suggest that students with schematic deficits would find the whole chipmunk lesson situation unfamiliar and confusing, and would predict equivalently depressed attention regardless of instructional language condition. The effect on performance of reducing the complexity of processing demands would be either positive or negligible. Clearly, the findings are inconsistent with these predictions.

The final deficit model to be considered here involves a strategic deficit explanation. According to this explanation, the main difference between the Special Needs students and their Regular peers is that the Special Needs students have an underlying deficit or delay in their development of information processing strategies (cognitive processes). (Note that this explanation would be unlikely to account for attentional or performance differences of participants who were categorized as Special Needs solely because they were learning English as a second language.)

Cognitive researchers have defined and studied several types of cognitive and metacognitive strategies that people use to act upon incoming information to transform it, encode it into memory and retrieve it from memory at appropriate moments (Glover, Ronning, & Bruning, 1990; Mayer, 1987). Mayer, for example, describes these as including attention, rehearsal, organization, elaboration, various cognitive monitoring strategies, and various retrieval strategies. He further points out that children's knowledge of and ability to effectively use cognitive strategies depends on both their developmental level, and whether or not they have had the opportunity to learn them.

A strategic deficit explanation would suggest that due to developmental differences or few learning opportunities, many Special Needs students would not have learned to use cognitive strategies as effectively as Regular students to further their own learning. For example, they might not know how to use attentional strategies to select the important elements of the incoming flow of information or to sustain their attention when faced with a complex task. They might not know how and when to use rehearsal to retain a bit of information in short term memory or to store it in long term memory; or how to organize information into chunks to allow more complex processing in short term memory and more structured knowledge in long term memory; or how to meaningfully elaborate new information by building connections with known information. Kamhi (1989), who emphasizes the linguistic bases of reading, comments that "the research on strategy use is quite uniform in finding that poor readers do not perform as well as good readers on tasks that provide opportunities for strategy use" (p.84).

Findings of this research are partially consistent with a strategy deficit explanation. Special Needs students attended to the lesson less than Regular students, on average. Their drop in attention as pace of instructional language was reduced and redundancies were added could indicate a deficit in sustained attention; unless these students received rapid, successive "hits" of new information, they were unable to sustain attention to the task of listening.

While I do not have data that enable me to determine what proportion of the Special Needs students in this study could be described, in clinical terminology, as having "attention deficit disorder," the *Diagnostic and Statistical Manual of Mental Disorders* (third edition) says "the essential features are signs of developmentally inappropriate inattention and impulsivity .... In the classroom attentional difficulties and impulsivity are evidenced by the child's not staying with tasks and having difficulty organizing and completing work. The children often give the impression that they are not listening or that they have not heard what they have been told" (1980, p. 41). Wallach and Liebergott (1984), in a discussion about the issues surrounding how learning disabilities are defined and conceptualized, say that one of the central theories is that learning disabilities are due to a fundamental information processing deficit of neurological origin. This is also the point of view of expressed in the definition of learning disability accepted by the National Joint Committee on Learning Disabilites (1982). Whether persistant lack of sustained attention is conceptualized as a processing deficit arising from a neurological cause, as believed by many clinicians, or as a failure to have learned a particular set of attentional strategies, as suggested by many cognitive theorists, the resulting attentional behaviors are the same, and are consistent with the findings of this study. (Note, however, that only 10 of the 30 Special Needs students in this study were specifically identified as having learning disabilities.)

These findings were not consistent with the presence of deficits in other processing strategies for the Special Needs students (with the possible exception of cognitive monitoring, to be discussed below). When the Special Needs students attended to the lesson as much as their Regular peers did, they exhibited equivalent performance on learning outcome tasks (Figures 5, 6, & 7). If they had had encoding, or retrieval deficits relative to their Regular peers, these would have been reflected in lower performance regardless of attention levels. However, as these students were all very young, it is possible that neither the Special Needs nor the Regular students had yet learned to apply encoding or retrieval strategies beyond a rudimentary level, and that if we were to follow these children over time, as use of these strategies emerged, perhaps discrepancies between Special Needs and Regular students would also become apparent.

However, another possibility is that the fast, nonredundant condition was so complex that all of the children were precluded from using strategies. But when instruction was slower or redundancies were added, perhaps Regular students applied strategies to help themselves learn, whereas Special Needs students, having few strategies to apply, used the increased processing time to direct their attention elsewhere. Thus, slowing the pace and adding redundancies provided opportunities to use strategic learning, but only some students were able to do so (Kamhi, 1989).

Resource Allocation Explanation

Another way to interpret Special Needs and Regular students' attention to the chipmunk lesson and performance on subsequent tasks is to take the perspective that students actively allocate their attention and other cognitive resources, depending on what they perceive the demands of the task to be, how they calculate the costs and benefits of engaging in that task, and what other events or opportunities are simultaneously competing for their attention. In other words, Special Needs students might engage in instructional activities differently than Regular students because of strategic differences rather than strategic deficits. Looked at this way, it is clear that all of the participants attended to the listening task less when processing demands were decreased. However, why did the Special Needs students decide to allocate so much less attention to listening than the Regular students as instructional language was slowed and redundancies were added?

Certainly, for all of the participants, there was some degree of "environmental press;" that is, events other than the listening task impinged upon participants' awareness.

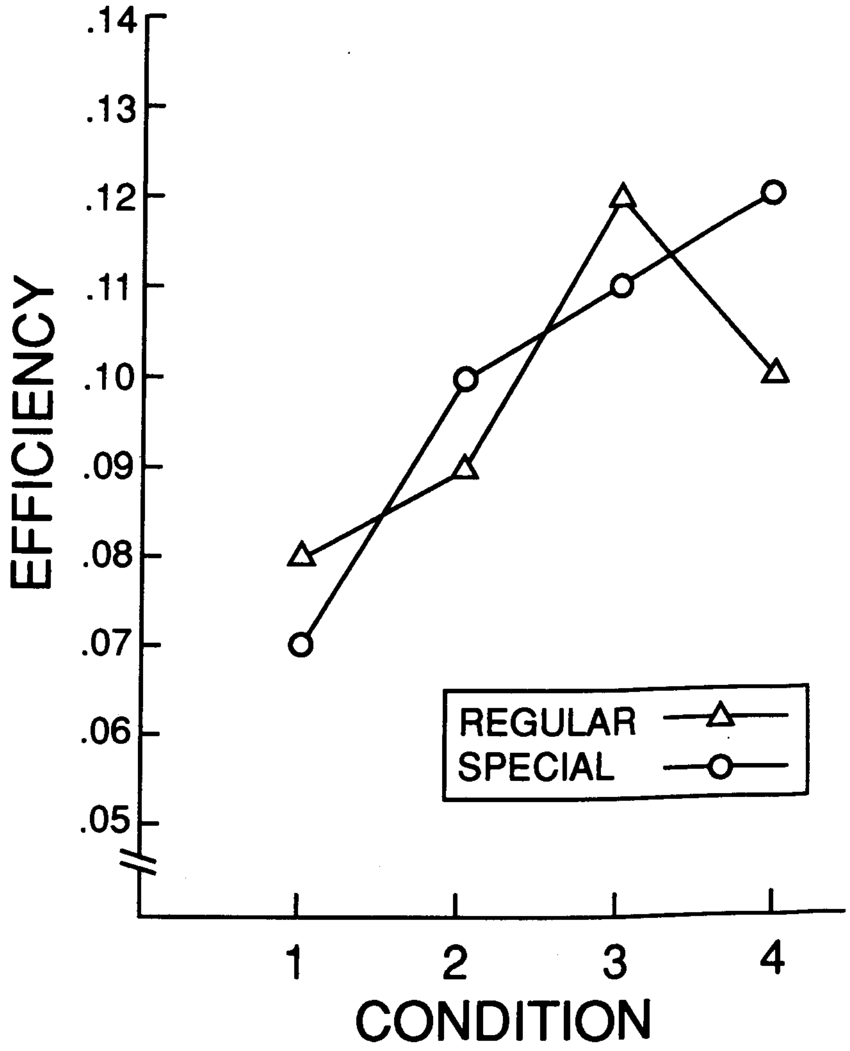
At any moment, particular students could have found a peer's acts, noises in the hall, objects around the resource room, or thoughts about their daily concerns more compelling than the instructor's presentation of the chipmunk lesson. However, there was little evidence to suggest that this environmental press was greater for Special Needs than Regular students, or that environmental press increased as processing demands decreased.

Thus, differences between Special Needs and Regular students' allocation of attention would seem to be best explained either as due to differences in how the task demands were perceived, or due to different conclusions about the costs and benefits of attending to the lesson. All of the participants seemed to have judged the fast, nonredundant condition demanding, as, on average, they all attended closely to the lesson in this situation. However, perhaps Special Needs students interpreted slow pace or redundancies as indicators that the task was easy, and therefore allocated much of their attention elsewhere. If so, this was a misjudgment, as the semantic and syntactic complexity of the lesson, the number of ideas that needed to be thought about, and the number of inferences that needed to be made remained unchanged and presented a challenging listening task even under conditions of reduced processing demands.

Thus, Regular students recognized the listening task as demanding even when some processing demands were eased, whereas Special Needs students did not. Returning briefly to a deficit model explanation, this would suggest that, compared to Regular peers, Special Needs students' comprehension monitoring strategies (rather than their attentional strategies) were inadequate. Because they misjudged the complexity of the listening task if instructional language was slow-paced, they chose to allocate their attention elsewhere, and then failed to learn as much as Regular students who attended more in these conditions. This explanation would be consistent with a number of studies on children's comprehension monitoring, especially in reading tasks (Kamhi, 1989).

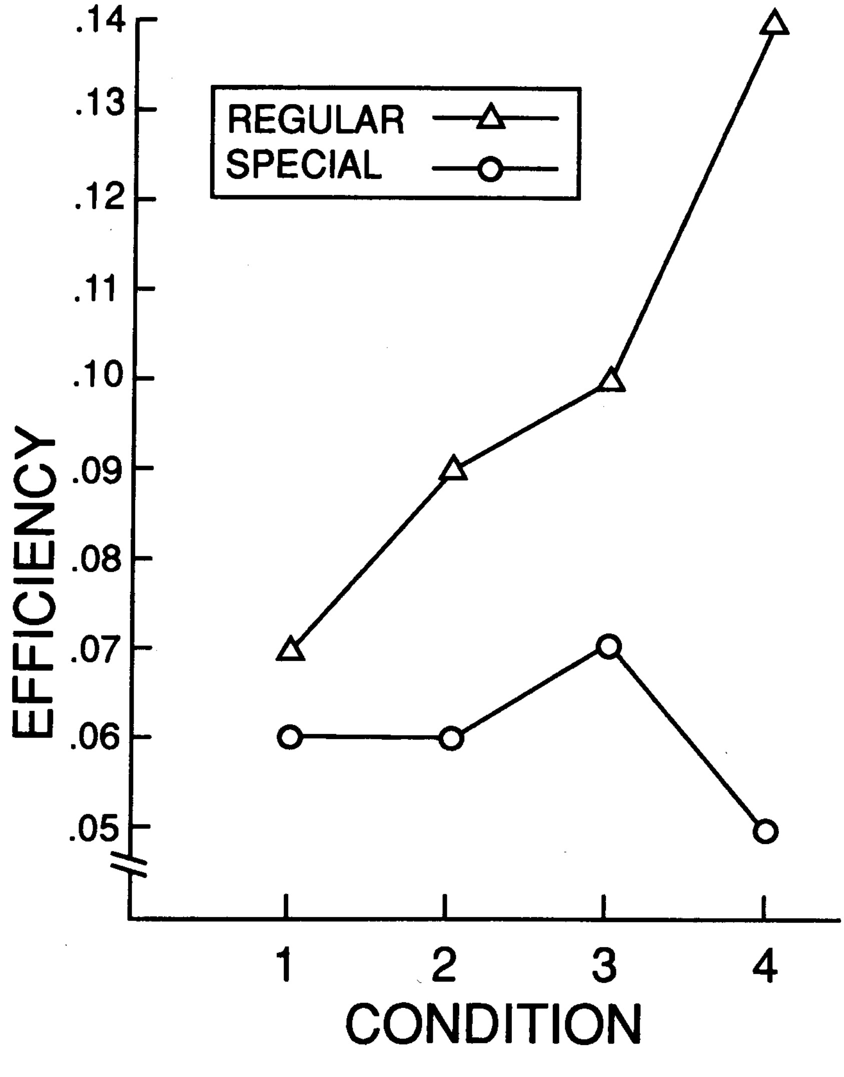
Alternatively, Special Needs and Regular students could have interpreted the costs and benefits of the listening task differently. Perhaps the way the participants construed the listening task was not simply to "learn as many facts about chipmunks as possible," but, rather, to maximize the output (number of facts learned), while, at the same time, minimizing the input (amount of attention paid to listening). In other words, perhaps the participants' objective was to allocate their attention and other cognitive resources efficiently so that they directed as much attention was was necessary to learn "enough" about chipmunks, while still being able to direct some amount of attention to other interesting thoughts and events.

To examine this idea further, I calculated "efficiency ratios" by simply dividing Special Needs and Regular students' Picture Task scores by their percent attention for each instructional language condition, and graphed the results (see Figure 15). Equivalent graphs were produced for Verbal Recall scores (see Figure 16). This permits cross-condition comparisons of the relative efficiency of participants' attentional strategies.



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 15. Efficiency of regular and special needs students' attentional strategies for the picture task by instructional language condition.



Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 16. Efficiency of regular and special needs students' attentional strategies for the verbal recall by instructional language condition.

Figure 15 shows that Regular students obtained their highest Picture Task scores per amount of attention allocated when instructional language was slow and nonredundant, which was also the condition in which they received their highest absolute Picture Task score, on average. Special Needs students received their highest Picture Task score per amount of attention allocated when instructional language was slow and redundant, which was also the condition in which they received their lowest Picture Task score, on average. The efficiency of Special Needs and Regular students' attentional strategies in each condition was comparable, and for all the students, relative efficiency increased as processing demands decreased. Compared to Regular students, Special Needs students simply accepted lower benefits (Picture Task scores) in return for lower costs (amount of attention required).

However, Figure 16 shows that the efficiency of Special Needs and Regular students' attentional strategies were no longer comparable within-condition for the verbal recall task. Regular students' attentional strategy still increased in efficiency, as indicated by a ratio of Verbal Recall score to percent attention, as processing demands decreased. But Special Needs students' efficiency stayed around the same low level for each condition, and below that of Regular students for every condition. When Special Needs students' learning was measured using a verbal recall task, reduction in processing demands yielded neither better absolute learning, nor more efficient learning. One way to interpret this is that Special Needs students' attentional strategy for learning facts resulted in better performance in a more structured, concrete task (Picture Task) than in a more elaborative, verbal tasks (Verbal Recall), whereas Regular students' strategy was effective for either type of learning outcome task.

Other Influences on Learning

In this section, I discuss three other influences on participants' learning that were not tested within the original causal model. These include the role of sex, the role of peers' attention to the chipmunk lesson, and the differences between instruction that involved telling and instruction that involved doing.

Role of Sex

I had not anticipated finding differences between boys and girls in language ability or proficiency, attention, or learning outcomes. As reported earlier, however, boys scored higher on the *TOLD*, and girls attended to the lesson more, at statistically reliable levels. The attention difference between boys and girls is consistent with many teachers' and parents' observations that young boys, whether due to cultural expectations or biological differences, tend to be more physically active, inattentive, and disruptive in classrooms than girls. The boys' better performance on the *TOLD*, however, is inconsistent with often-reported findings that girls demonstrate greater verbal ability than boys (Maccoby & Jacklin, 1974).

In separate causal models for each sex (Figure 14), Special Needs reliably explained some of the variance in Verbal Recall for boys but not for girls. Pace reliably explained some of the variance in Picture Task for girls but not for boys. The structure of the two causal models and the strength of the paths was otherwise similar for boys and girls.

The differences in the causal models would seem to follow from the initial difference in *TOLD* and the Attention difference. Given the differences found here, including sex as an individual difference variable in future tests of this causal model would seem approriate, if only to determine whether these apparent differences were artifactual.

Role of Peers' Attention

A mediating variable reflecting the influence of peers' attention to the chipmunk lesson was included in an alternative causal model following my observation, during data collection and analysis, that some groups of children seemed to behave differently during the chipmunk lesson than others. It seemed that, depending on the personalities in each group and how they related to each other, whole groups of children would take on attitudes of quiet, passive listening; active, enthusiastic listening; inattentiveness whenever they thought they could get away with it; active redirection of other group members' attention back to the task; and so on. In other words, even during this very brief set of instructional activities, a kind of group "chemistry" and cohesiveness developed that seemed to mediate individual students' engagement in the listening task.

This impression was supported by the findings of the alternative causal model including Peer Attention. Peer attention mediated the effects of pace of instructional language on individual students' attention and on the verbal recall task. Slowing pace resulted in reduced peer attention. Individual attention to the lesson was higher if peers paid attention, and lower if they did not. These findings are consistent with classroom process researchers' findings about the importance of student-to-student interaction in influencing how instructional activities unfold (Cooper, Marquis, & Ayers-Lopez, 1982; Cook-Gumperz & Gumperz, 1982; Eder, 1982; Fillmore, 1982). However, these preliminary findings await further tests on another sample of students before any strong interpretations can be made.

Telling Versus Doing

A current important trend in education research and practice involves developing educational experiences for students that enable them to discover ideas and ways of doing things. This approach follows from Bruner's (1966) theory about discovery learning, in which he argued that knowledge would be more meaningful and more likely to be retained when learners actively discovered new ideas rather than merely being told about them. I agree that students' active discovery of ideas ought to have a central place in the way teaching and learning takes place in schools, and I also believe that expository instruction can contribute to effective teaching, especially when the role of instructor is taken by students or visitors from the community, at times, as well as by the teacher.

In designing this study, I hoped to examine what kind of learning took place during expository instruction as compared to that which occurred during other types of learning activities. Therefore, I planned that the instruction would begin with a short expository lesson, and continue with an individually completed picture task, a group discussion, a drawing activity, and an individual student-instructor interview, in which the student would take on the role of "chipmunk scientist." These learning activities involved, respectively, listening, visual reception and prompted recall, communicative interaction, visual expression, and verbal expression. I hoped that through observing the students as they engaged in these activities, and by comparing their two learning outcomes (Picture Task and Verbal Recall), I would better understand how different sorts of activities helped the children learn about chipmunks in different ways.

While I found that paticipants' Verbal Recall was in part explained by their Picture Task scores, it seems that, for this part of the study, my expectations exceeded my grasp. In the first place, because the two learning outcome tasks involved such different skills and tested different kinds of knowledge, I was not able to directly compare the two scores to draw conclusions about "how much" learning had taken place after expository instruction alone, as compared to after both expository instruction and other instructional activities.

For example, a high Verbal Recall score relative to the Picture Task score for any particular student might indicate that the student had benefitted greatly from the learning activities that followed the expository lesson. Or this result might merely show that the student felt much more comfortable expressing knowledge about chipmunks verbally in no particular order than on a highly structured multiple-choice test. Or, yet another possibility is that, because the expectations the student had during listening to the lesson, cognitive strategies were used that favored retrieval via free verbal recall. For a student whose Verbal Recall score was low relative to her Picture Task score, possible explanations could be that the nonexpository instructional activities had actually interfered with memory of the facts heard, or that Verbal Recall was constrained by low expressive language abilities, or that the student had more experience with structured approaches to demonstrating knowledge (i.e., a schema for doing worksheets, but not a schema for individual interviews). With these data, I cannot untangle the possible explanations for these results.

In the second place, observations of the children throughout the series of activities also seemed insufficient to enable interpretions about the influences on learning of "telling" versus "doing." The series of activities following the lesson might not have constituted a sufficiently good example of "doing," as they were very brief, selected and structured by the instructor rather than by each individual student, and used Bruner's (1966) iconic and symbolic modes exclusively (rather than the enactive mode, which might of better facilitated discovery for this age group).

I made three interesting observations, however. The first was that, during the final interview (metapragmatic probe), the majority of students said that they thought the learning activity that had helped them learn the most about chipmunks was the "scientist's" lesson (that is, the expository instruction). A few said the Picture Task was most helpful, and a few said they already knew a lot about chipmunks because of books they had read or parks they had visited. A few pointed out that the lesson would have been better if I had brought a chipmunk along to show them. No-one said that talking to their classmates, drawing pictures, or telling me about chipmunks was most helpful for learning. It is quite possible, of course, that the students said what they thought I wanted them to say.

A second interesting observation was that during the group discussions, students quite frequently expressed misconceptions about chipmunks. It seemed to me that participants in this study were very receptive to what other students had said because, in the subsequent individual interviews, as students took turns being chipmunk experts talking about chipmunks, they frequently repeated the misconceptions that they had heard expressed in the discussion group earlier. This is interesting because it is consistent with the often-repeated caution about discovery learning leading to the acquisition of misconceptions (Mayer, 1987).

Another reason this observation is interesting is that it suggests a method of tracing some of the sources of information that come to make up any particular participant's knowledge stores. When a learner expresses a "true" fact, the researcher can never know for sure that the learner has come to know that fact because of instructional manipulations in the study, as it is always possible that the study participant already knew that fact before. But if the learner repeats an uncommon statement or misconception, the researcher can trace that knowledge to its source with greater confidence. Thus, it would be interesting to follow-up with an analysis of these students' repetitions of misconceptions as a way to trace their sources of knowledge.

A final observation was that, frequently during the drawing activity and less frequently during the group discussion, some students mentioned cartoon chipmunk characters that they had watched on television. During the group discussion, if a student mentioned cartoon chipmunks, his peers typically responded with laughter, and redirected the discussion back to the kinds of chipmunk facts that I, as the chipmunk scientist, had presented. After-all, the video camera was watching, and I was just a few feet away "doing some writing." But during the drawing activity, as the students chatted freely among themselves with little direction or attention from me, cartoon chipmunks were frequent topics of conversation, and several of their pictures depicted chipmunks doing fantastical things, like shooting nuts out of an elaborate machine at their enemies.

The point is, televised cartoon chipmunks and their antics probably form a sizable part of grade two students' knowledge about chipmunks. Furthermore, most of these students seem to know that this type of knowledge is inappropriate to mention in "school-type" of tasks. This is a type of prior knowledge that I had not originally anticipated.

Implications

In this next section, I discuss both the theoretical and instructional implications of the findings of this study.

Theoretical

A first, and rather obvious point to make, is that classroom interaction is complex. Each person in the classroom brings knowledge, expectations, and goals. What happens in a classroom depends not only on what each person intends to do, but also on how each person acts upon and reacts to each object, person, behavior, and event in that situation. Each person's history of experience with that setting, those objects and those people, or similar ones, guides some of the thought processes and behaviors he or she has as the instructional events proceed, and yet some of the acts or thoughts are prompted by moment-by-moment interactions with others.

The findings of this study showed support for the initial causal model hypothesized. I conceptualized classroom learning from instruction as depending on what learners brought to the learning situation, what the instructor brought, aspects of the context, and what actually happened during the teaching and learning. Results of testing this model showed statistically reliable relationships between the variables representing the elements in this model. In particular, students with greater language ability/proficiency and students who attended more closely to the lesson learned more about chipmunks. Students who did well on the multiple-choice Picture Task also tended to do well on the Verbal Recall task. And slower, more redundant instructional language tended to aid learning, except when it resulted in much reduced attention to the lesson, as was typically the case for Special Needs learners.

However, the model was found to be insufficiently elaborated. That is, more variables need to be added to more closely approximate the complexity of actual teaching and learning processes. Those variables might include, in particular, aspects of student-student interaction, and more adequate specification of prior content knowledge.

While one result was support for this particular causal model, a more general implication of this research is that it is useful and productive to track instructional, learning, and interactional processes in a detailed way in process-product type of studies.

Process-product research designs typically have involved setting "process" variables at certain predetermined levels and measuring their effects, as was done with the two instructional language variables in this study. However, some of the most interesting findings of this study arose from the way another process variable, Attention, was handled. Attention was allowed to vary normally, and those variations were measured and correlated with other process variables, prior individual difference variables and subsequent learning outcome variables. Using this approach, certain theoretical explanations for how learning was taking place could be ruled out, while other explanations could be seen to be consistent with the data. Thus, incorporating the technique of making detailed recordings of naturally-varying interactional processes like attention, as has been used by sociolinguistic and ethnographic classroom researchers, into a causal model quantitatively testing the relationship of several individual difference and process variables with learning outcome measures, creates a powerful way to test theories about learning processes and learning outcomes.

A final important implication of this research has to do with the particular explanations supported by these data. Findings about how these students learned about chipmunks were consistent with two different theoretical perspectives. One of these viewpoints is that students actively allocate their personal resources (knowledge, skills, attention, and effort) depending on their goals and what they interpret the demands of the learning task to be. In tracking any particular student's behaviors during the instructional activities, as was done in the selected case profiles, this certainly seemed to account for what individuals did. Within this point of view, it seemed that students with special learning needs made different choices about attending to expository instruction than other students.

The other perspective that was supported was the strategic deficit view. If one assumes that students with special needs learn differently than "every-one else" because they have deficits either at a neurological level, or in what they have so far learned, these data provide evidence for that deficit residing either in their attentional processes or in their comprehension monitoring processes. Of course, it is also possible to view this as a strategy "difference" rather than a "deficit," that presents as a deficit only because the instructional situation is insufficiently adapted to those individuals' different way of responding to instructional language (see Maxwell & Wallach, 1984, for a discussion of this perspective).

Instructional

There are a number of practical implications for teaching and learning that arise from this study. One obvious implication is that it matters how teachers talk. These results showed a statistically reliable effect of pace of instructional language (and, in some situations, redundancy of instructional language) on participants' attention to a lesson and on their learning outcomes. It is plausible that pace and redundancy of instructional language would also have effects on students' attention and learning in other classroom instruction, and for other students. Thus, it would seem useful for teachers to become aware of the pace and redundancy of their instructional language and how these might differentially affect learners in their classrooms, and to monitor and adapt their instructional language accordingly. And, as instructional language is not characterized by just pace and redundancy, but also by syntax, discourse structure, reference, topic management, and so on, teachers would do well to also consider these other aspects of their instructional language, observe their effects, and modify instructional language depending on the feedback they receive from students.

Another important implication for teachers of these findings, however, is that modifying instructional language to best promote attention or learning is not straightforward or "algorithmic." It depends on the students and their goals, the topic, the type of learning the instructor wants to promote, and whether the teacher is more concerned with the students' levels of attention or their learning outcomes. This suggests that it is imperative for instructors to know their students (which implies thorough and ongoing assessment), to pay close attention to feedback, to know their own goals, and to make thoughtful, informed decisions about the way they use instructional language.

One reason no simple rule about how fast or redundant teachers' language ought to be can be presented is that there was an aptitude-treatment interaction; students with special learning needs and regular students responded differently to characteristics of instructional language. Special needs students attended the most and had the best learning outcomes when instructional language was fast-paced, regardless of how learning outcome was measured. Regular students attended slightly more to fast-paced instructional language, but had their best learning outcomes on the multiple-choice picture task when instructional language was slow and nonredundant, and they had their best learning outcome on the free verbal recall task when the instructional language was both slow and redundant.

Teachers could come to the following conclusions about how to adjust their instructional language. If having the students pay close attention is the most important goal, when addressing the whole class, teachers should either talk fast, or teach students (especially students with special needs) a strategy of attending more to slower instructional language.

If maximizing learning outcomes is the most important goal, then teachers ought to differentiate their instructional language depending on whether students have special learning needs, and depending on the learning outcome they want to promote. So if they want to promote the kind of learning measured by the picture task, they should talk fast and redundantly to special needs students, but slowly and nonredundantly to regular students. If they want to promote the kind of learning measured by the free verbal recall task, they should talk fast to special needs students, but slowly and redundantly to regular students. (This, of course, would be impractical for whole-class instruction of heterogenous classes, and thus implies the necessity of grouping students and individualizing direct instruction).

If remediating the perceived deficits of special students is their main goal, teachers would see special needs students' inattention to slow instructional language as a deficit (because they differ in this regard from "regular" students), and should teach them to attend better to slow-paced instruction. They should then use slow, redundant instructional language with all of their students.

Finally, if a teacher's goal is to elicit the most similar attention levels and performance from all his or her students, he or she should talk fast and nonredundantly to all the students because there is the least between-group variance in attention and both outcome tasks in this condition. However, from the strategy deficit perspective, this approach could have negative long term implications for both regular and special needs learners. Regular learners would have reduced opportunities to use learning strategies, and thus, they would learn less than they were capable of learning. Special needs learners still would not learn to use learning strategies necessary for slower-paced tasks (like reading, for example).

Another implication of this research is that teachers and students can be seen as having different goals. If teachers' goals in adjusting their instructional language (or in making other instructional decisions) can be described as finding the best way to get students to pay attention to a lesson, or finding out how to best promote particular learning outcomes, students' goals might centre around figuring out how to best allocate their attention to the learning task at hand, as well as to other simultaneous, interesting events and trains of thought. Thus, students would be well-served by learning how to accurately assess the costs and benefits of allocating attention to the various events, tasks, and thoughts impinging upon them at any moment. Teachers, on the other hand, need to keep in mind that their goals and students' goals might often be only partially aligned, or at cross-purposes. One of the skills of a good teacher is to create learning situations that either match or help develop individual students' personal learning goals.

Limitations

In this section, I address limitations of this research. I first review some of the specific limitations of this study, then I go on to briefly comment on some wider conceptual and methodological issues.

Specific to this Study

A number of limitations of this study can be attributed to the instruments used. The receptive vocabulary subtest of the *Test of Language Development* is clearly neither a perfectly accurate measure of language ability nor of English language proficiency. To the extent that there is error in this indicator, one of the basic assumptions of path analysis is violated. (One way assess this type of threat in future studies would be to use LISREL rather than path modelling.)

The attention measure can be criticized for a similar reason. While this indicator measured whether students were looking at me or not at any given moment, it can only be assumed that looking implied they were listening. I had no error-free way to determine whether anyone was "really" listening at any moment.

Both of the learning outcome tasks measured only students' performance of particular activities. Many kinds of error and unmeasured variables could have contributed to the obtained scores. Thus, Picture Task and Verbal Recall were probably far from being perfect indicators of what the participants actually learned. Most of the other indicators generated in post hoc and supplementary analyses could be criticized on similar grounds.

A second type of limitation affecting interpretation of these findings is misspecification of the causal model. Clearly, not all of the variance in participants' attention, performance on the multiple-choice picture task, or their free verbal recall of chipmunk facts was accounted for. Some important causal variables must have been omitted from the model. Obvious candidates include a measure of prior content knowledge, an indicator of participants' expectations and/or goals, and a measure of student-student interactions.

A number of aspects of the methodology can be seen as problematic. For example, the entire set of instructional activities can be criticized for not occurring within a completely naturalistic classroom situation. Issues here include the use of a stranger as the instructor, the presence of videotaping equipment, the way students were grouped, the resource room setting, and the "unnatural" constraints on the lesson (including the use of a monologue rather than reciprocal communication, and the avoidance of supporting concrete and visual materials). My taking the role of both participant (as the instructor) and "dispassionate" researcher must have influenced both what happened during instructional activities, and how I later came to construe and analyze the data. I have tried to convey a little of my perspective about the students and tasks in the selected case profiles, but this issue remains largely unanalyzed. Another example, discussed earlier, is the way interpretation of Picture Task and Verbal Recall results was confounded in the design. The cause of the differences between Picture Task and Verbal Recall outcome scores cannot be disambiguated because learning by listening or doing, the type of knowledge being measured, and students' expressive language abilitites have been confounded in the design.

A final type of limitation that could be pointed out concerns a more conceptual issue. This is the fundamental conception of what "learning" was considered to be in this study. Both of the outcome tasks involved some kind of display of how many "facts" about chipmunks students were able to accurately produce. This can be criticized on several fronts. Recalling sets of facts is equated with learning, yet, surely, learning involves much more than simply being able to repeat back a set of facts heard earlier in an expository lesson. I might argue that students were not limited to mentioning simple facts like, "chipmunks have stripes around their eyes," but were also credited with inferences based on such facts, such as, "chipmunks help save the environment by planting seeds that grow into trees." However, the more sophisticated inferences were weighted the same as the simplest statements of fact, and many aspects of knowledge acquisition remained unaccounted for.

While I have held to the viewpoint throughout that learners construct their own knowledge, the kind of learning reflected in this research design is more reminiscent of a "pouring the facts in," or receptive learning kind of perspective. The multiple-choice picture task was a measure of what participants "knew" about chipmunks following the expository lesson. Yet, responses were scored merely as "right" or "wrong," rather than being examined as a hint about the ways participants had constructed their understandings. Similarly, the free verbal recall task was scored only for the reappearance of facts or ideas that had previously been presented in the lesson, thus any construction of novel understandings were not recognized as "learning." (In my defense, I did consider these issues and examine the picture task responses and verbal protocol informally to try to understand how the children thought about chipmunks' lives, but I was not able to think of an elegant way to incorporate this more complex way of looking at learning into the quantitative analyses.)

Conceptual and Methodological Issues

It is possible to explain some of the limitations of this study as arising for logistical reasons, such as the difficulty of scheduling 120 students of 13 teachers in 5 schools to participate in two sessions within a narrowly proscribed time period, and doing it in a way that the research activities would contribute to the participants' learning and not unneccesarily waste anyone's time. Some of the limitations have arisen directly from inadequate initial conceptualizations constraining the design of the research. And yet, some of the limitations point to more profound underlying conceptual and methodological issues.

It seems to me that kinds of the multivariate statistics used in this study are simply inadequate to reflect the complexity of the dynamic, interactive world in which we live, or, more specifically, of the dynamic, interactive classrooms in which we teach and learn. Classroom learning involves more variables in complicated relationships than we can simultaneously examine in one big model. If I wish to persist in examining learning through classroom interaction using multivariate statistics in future research, it seems to me I am condemned to forever look at incomplete sets of puzzle pieces in series of only partly satisfying studies.

Furthermore, in looking at mean behaviors of groups to draw conclusions, the individual histories, expectations, goals, thoughts, acts, and learning of each Geoffrey, Jonie, and Mika are folded into the average and lose their unique meaning. In order to permit meaningful summarization and interpretation of data, these multivariate approaches to analysis necessarily focus on the general rather than the particular, the ways in which data are homogeneous rather than the ways in which they are heterogeneous, and the central tendencies rather than the outliers (Barlow & Hersen, 1984). In classroom interaction research, this compromise might be too dear.

Another aspect of the same problem of taking a multivariate statistical approach involves how to handle "context." It is impossible to truly "hold it constant." Even if a researcher arranged the physical setting the same way, and used the same scripts, procedures, and equipment (as I tried to do), every person's unique history would ensure different internal constructs (motives, expectations, knowledge constructs), which would result in each person interpreting contextual factors (setting, task, and so on) in different ways. Furthermore, while context cannot be held constant, neither can the ways it differs for each individual be adequately specified, as the internal constructs are not available for study, and external indicators used as proxies (traces, interviews, behaviors) are partial, often misleading, hard to validate, and susceptible to being interpreted as showing what the researcher expects to see.

These sorts of problems are, no doubt, why many classroom researchers have taken qualitative approaches to studying classroom interaction. The particular is not lost, and aspects of context and sequences of events can be described richly. Participants' interpretations can be solicited, and the researcher's perspective and influence is acknowledged rather than denied.

It seems to me, though, that this solution does not avoid the fundamental problem. Description replaces explanation. Details replace generalities. One just ends up with a different set of incomplete puzzle pieces, and the whole remains elusive.

What is an idealistic, not-so-young researcher to do? Despair? Should I accept that the scientific enterprise involves examining rather trivial components, and that asking bigger, more complex questions is impossible? Should I eschew empiricism, and throw away measurements and video cameras in favour of some other scaffolding to seek understanding?

My present solution is to conclude that no one study can be perfectly coherent and complete, no matter what conceptual framework or methodology is used. The problem is epistemological, and the only real choice is to keep "slogging along through the mess." In order to do so, I have developed five guidelines for my own future research: 1) Accept that any finding is partial, and rooted in its context. 2) Different results do not necessarily invalidate previous results, but might just focus on a different aspect of the problem. Apparently contradictory findings can both reflect different aspects of the "truth." 3) Greater knowledge will come through the accretion of many little related bits of knowledge over time. 4) Just as we have accepted that there can be "ill-defined problems" and "heuristics," we need to accept that evidence can also be (necessarily is?) "fuzzy." 5) We need to keep the big problems in mind, even though we are sure to fall short in any one study.

Future Research Needed

This section includes brief remarks about data collected during this study but not analyzed or reported on here. Ideas for future research suggested by findings of this study are also discussed.

Unexamined Data

Data collected included a moment-by-moment record of participants' attention. It would be interesting to use these data in a micro-analysis, correlating sentence-by sentence variations in attention with students' participation in the discussion group and their performance on learning outcome tasks, in an attempt to trace the source of some of the facts that each student came to remember. Secondly, as discussed earlier, I made some observations about some students' misconceptions about chipmunks. The origin of these misconceptions and their propagation could be traced using these data. Finally, I could examine what the students said about the instructional activities during the final interview and correlate this with other learning and attention variables, to check the influence of students' perpectives. This could also be done in an interpretive way.

Future Studies

Based on the findings of this study, there are three obvious directions for future studies to take. The first would be to retest the causal model on another sample, incorporating some additional process variables, and testing prior knowledge more thoroughly. Secondly, the same model could be used to examine the effects of other aspects of teacher's language or other instructional manipulations.

Finally, the learning differences of special needs and regular learners could be further examined in a series of studies. One study might involve a larger sample of special needs participants, grouped by type of special learning need. Patterns of attention and learning could be contrasted, and examined using more powerful statistical procedures. Another approach might involve tracking an individual special needs or regular learner through various learning tasks, and using videotaped records and thick description to observe and reflect on the interaction of variables examined in this study. A third possibility would be to use single case experimental designs employing multiple baselines and replications with several participants (Barlow & Hersen, 1984; McReynolds & Kearns, 1983) to further examine how language ability, aspects of instructional language, attention, and so on interact for different individuals. In such a program of research, I would capitalize on the advantage of convergent perspectives and research designs not only within one study (as attempted here), but also aggregated across studies.

Conclusion

In conclusion, I refer back to the three major purposes of this research. One purpose was to test a causal model linking aspects of language ability or English language proficiency and two aspects of instructional language with attention and learning outcomes. The theorized model was supported, but insufficiently elaborated. The findings have both theoretical and useful instructional implications.

An examination of differences between special needs students and their peers showed differences arising from complex interactions between instructional language, attention, and the type of learning outcome measured. Two ways of explaining these results include a strategy deficit perspective and a view that students differ in the ways they choose to allocate their resources. These findings have implications for whether and how teachers ought to modify their instructional language for different kinds of learners.

Finally, the goal of integrating findings from two different research traditions in a "weakly" convergent study was partially met. The causal model developed through reflection on classroom language processes largely studied within sociolinguistic and ethnographic traditions of classroom research was supported but found to be incomplete. A naturalistic process variable, Attention, was incorporated in the causal model. The contextual nature of instructional interaction was considered, and addressed in the design in various ways. Yet in most ways, the study was very much in the process-product tradition. Overall, the study yielded statistically reliable, theoretically interesting, and instructionally useful findings.

On the other hand, I found causal modelling as employed in this study to be too simplistic to capture "the big picture." While I was interested in "big" questions, I arrived at "little," partial answers. Causal modelling provided a more rigorous test of language-learning links than another descriptive study might have, but at the high cost of using too few and overly simplistic variables. It seems, in retrospect, that capturing "the big picture" in any one study is an unrealistic goal.

While useful findings can be obtained, the use of even weak convergence in a single study risks violating central assumptions or constraints of both paradigms. For example, substituting a *TOLD* subtest for thick analysis of linguistic knowledge is inconsistent with a sociolinguistic/ethnographic perspective, while the inclusion of many ecologically valid process variables like Attention would exceed the capabilities of process-product quantitative methodologies (or at least those types used in this study). The risk of convergence is incoherence acceptable to neither approach. Perhaps the answer is to strive for convergence over a series of studies within a program of research.

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APPENDIX A

INSTRUCTIONAL LANGUAGE STUDY: TEACHER INTERVIEW FORM

Teacher's name____________________________

Class type: (circle) yr 3 yr 2/3 split yr 3/4 split
French Immersion English

On the attached checklist, beside each student's name, please fill in the following information.

B.D.: Birth Date: day/month/year; e.g. 27/09/84
GRADE: Present grade placement
CTBS: Canadian Test of Basic Skills (most recent avail)
1) Listening Test Raw Score (RS)
2) Language Total Raw Score (RS)
DATE: Test date of the reported CTBS score: day/mo/yr

The remaining categories reflect YOUR IMPRESSIONS only.

LANG: Oral language abilities (speaking & listening). Indicate Low (LO) if these seem below average, Average (AVE) if about average, or High (HI) if higher than average.

Check any of the following sections if it is your impression that the student has this (these) special needs:
ESL: English as a Second Language
LD: Learning Disability
BD: Behavior Disorder (or Emotional Disturbance)
MH: Mental Handicap
SP/LG: Speech or language delay/disorder
OTH: Other special needs, such as hearing impaired, gifted, or physically disabled. If you check this column, please describe below.

NAME	BIRTH DATE (day/mo/yr)	GRADE	CTBS Scores			LANG (lo, ave, hi)	Check if applicable					
			Listen-ing	Lang. tot.	DATE of test		ESL	LD	MH	BD	SP/LG	OTH

APPENDIX B

PICTURE TASK: STATISTICAL ANALYSIS

Statistics were calculated on the Picture Task to assess validity of the test (did it appear to measure learning about chipmunks?) and its reliability as a scale. The validity analyses were calculated using a subset of 18 subjects from the pilot data from whom both pretest and posttest scores were collected. The other psychometric analyses were calculated using the full set of 120 study participants.

Validity Analyses

The multiple choice Picture Task was administered to 18 students prior to presenting the chipmunk lesson (pretest), then again following the chipmunk lesson (posttest). Mean pretest score out of 12 was 4.33 with a standard deviation of 1.57. (This was somewhat higher than the pretest average of 3.90 with a standard deviation of 1.69 achieved by the full set of 30 students who were pretested in the pilot studies. Also note that the mean score that students would be expected to achieve by chance alone was 2.40.) Mean posttest score was 6.56 with a standard deviation of 2.12 (for the full set of 24 subjects, $M = 6.62$ and $SD = 1.93$). A paired samples t-test (two-tailed) calculated on the pre-post scores of the 18 students found $t = 6.97$ with $p = 0$, indicating that students performed significantly better on the Picture Task following the chipmunk lesson. The effect size, calculated using pooled standard deviation (Cohen's d-index as discussed in Cooper, 1984, Lapadat, 1991a, and Rosenthal, 1984), was 1.20, indicating that these students' knowledge of these facts about chipmunks as measured by their mean score on the Picture Task increased by 1.2 standard deviations following the chipmunk lesson. These statistics suggest that the Picture Task did measure at least some aspects of the students' learning about chipmunks.

Reliability Analyses

A reliability analysis of the Picture Task was conducted using Procedure RELIABILITY in the SPSS/PC+ statistical package. The question to be answered was: Is this test reliable in the sense that students' scores on the particular set of items selected for this test is similar to what their scores would have been had different items been administered?

The scale mean was 6.23 with *SD* = 2.30, calculated on 12 items for 120 students. These scores were normally distributed. The mean score by item was .52 (*Min* = .17; *Max* = .87; *SD* = .21). However, in examining the inter-item correlations, it is clear that these items were not correlated (*M* = .08; *Min* = -.22; *Max* = .42; *SD* = .13). This was also reflected in the low alpha of .52.

These statistics suggest that these students' scores on the Picture Task cannot be used as reliable indicator of their general knowledge about chipmunks, as their likelihood of learning any particular fact about chipmunks bore little relationship to learning any other particular fact. Thus, if 12 other facts had been used on the test, their scores might have been quite different. However, the Picture Task can still be used as an indicator of how well students learned these particular 12 facts.

Furthermore, this leads me to pose the interesting question as to whether it is appropriate to do this type of reliability analysis on this particular test. If the students began with limited prior knowledge about chipmunks (as suggested by the pretest score for these 12 facts only slightly above chance level), why should we expect that each "piece" of information they then acquire in listening to a lesson about chipmunks is correlated? That is, why should we expect that a particular child's memory that a chipmunk carries her babies by the skin of their stomachs ought to be related to that child's ability to recall what a chipmunk's burrow is like? The 12 facts were explicitly chosen so that each represented a different "bit" of information, and so that no answer could be inferred by thinking back to a previous question. The low inter-item correlations suggest that this objective in designing the test was, in fact, met.

A final point to note is that students' Picture Task scores were strongly predictive of their Verbal Recall scores (another measure of knowledge about chipmunks not limited to the 12 key facts). This indirectly supports the utility of the Picture Task as a measure of knowledge, despite the low alpha.

APPENDIX C

PICTURE TASK SCRIPT

[Turn off videocamera]

That's all I'm going to say about chipmunks for now. I'm going to give each one of you a picture book and a pencil. When you get your picture book and pencil, go find another place in the room to sit where you can work all by yourself. Don't write anything yet.

[Hand out booklets and pencils. Children move about and settle.]

Now, is everybody ready? First, print your name at the top.

[Hold up sample item; point.]

Now, look at the set of pictures on the first page [indicate]. There is a zero above it [point]. There are five pictures, A, B, C, D, and E [point]. Find the picture of a chipmunk. Put a circle around the letter for the picture that looks most like a chipmunk. If you're not sure, take a guess. Don't let anyone see which one you picked.

[Observe students circling picture.]

Has everybody circled one? Okay, look.

[Hold up sample item.]

I look at all the pictures. I see that this is the picture of a chipmunk. This picture right in the middle is the one I want. So I put a circle around the letter C.

If you picked a different one, you have time to fix it now. Put a circle around the letter C because that is the best picture of a chipmunk. Okay, good.

When you're ready, turn the page.

1. Look at number 1. Where does a chipmunk live? Circle the letter. [Repeat]

2. Look at number 2. What is a chipmunk's burrow like? Circle the letter. [Repeat]

Turn the page.

3. Look at number 3. How do chipmunks carry food? Circle the letter. [Repeat]

4. Look at number 4. What are chipmunk babies like? Circle the letter. [Repeat]

Turn the page.

5. Look at number 5. How do mothers move the babies? Circle the letter. [Repeat]

6. Look at number 6. What does a chipmunk do when it is in danger? Circle the letter. [Repeat]

Turn the page.

7. Look at number 7. What is a chipmunk's bed like? Circle the letter. [Repeat]

8. Look at number 8. What does a chipmunk do at dinner time? Circle the letter. [Repeat]

Turn the page.

9. Look at number 9. Where does a chipmunk store food for the winter? Circle the letter. [Repeat]

10. Look at number 10. What does a chipmunk's tree home look like? Circle the letter. [Repeat]

Turn the page.

11. Look at number 11. What happens to chipmunk babies in their 4th week? Circle the letter. [Repeat]

12. Look at number 12. What happens if a chipmunk forgets where some of its food is? Circle the letter. [Repeat]

Okay, now you have done all the pictures. _____ will come around and get them.

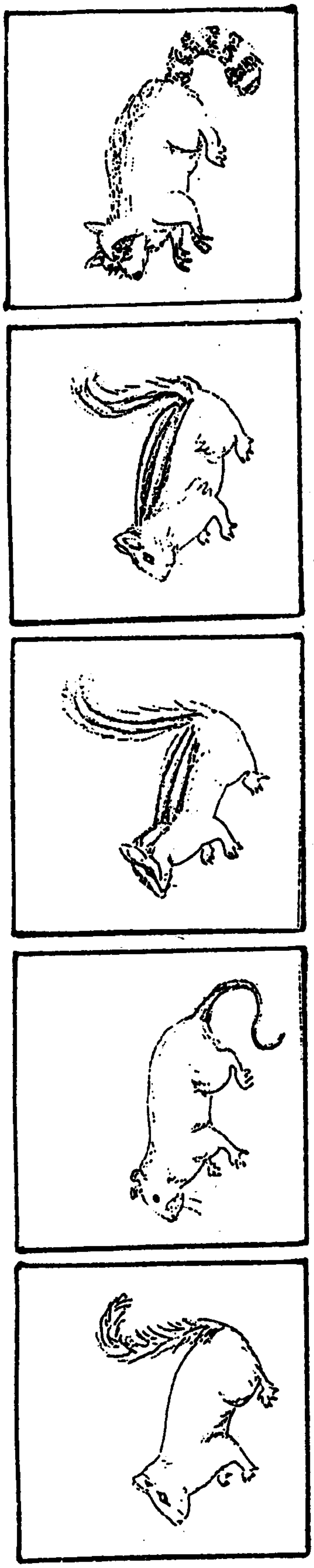
[Collect picture booklets and pencils, and note the subject number on each booklet.]

APPENDIX D

BOOKLET FOR MULTIPLE-CHOICE PICTURE TASK

The test booklet shown here has been reduced by a factor of 35%. The actual test booklets used in the study were 8 1/2 by 14 inches in format.

E D C B A



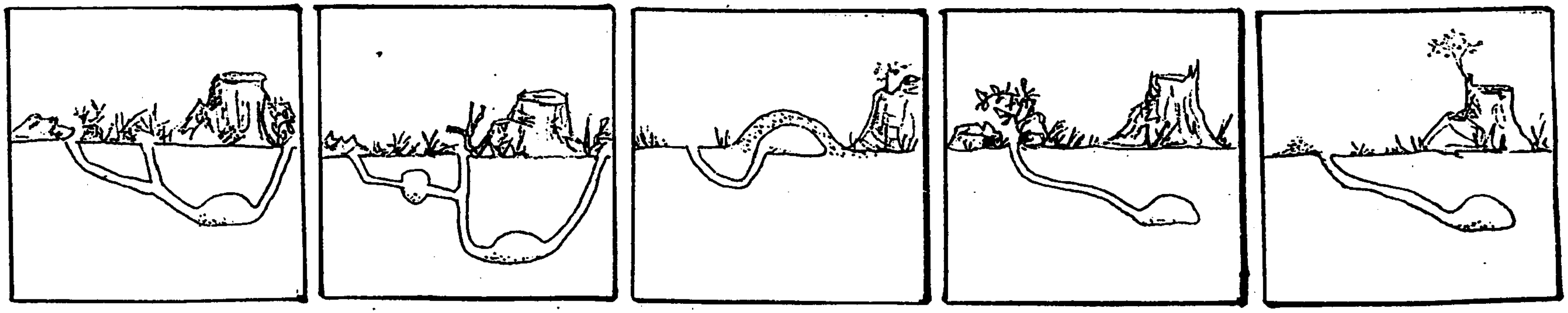
O

1

A B C D E

2

A B C D E



3

A B C D E

4

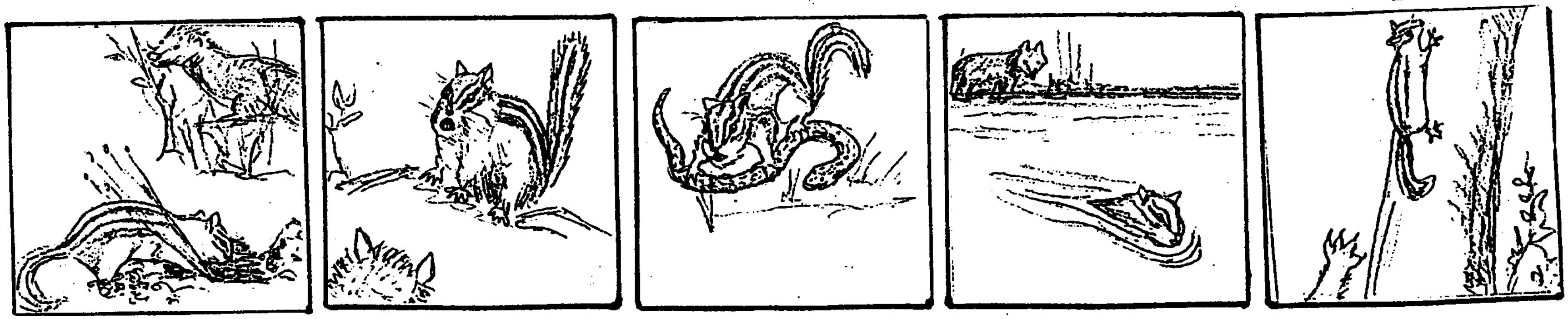
A B C D E

5

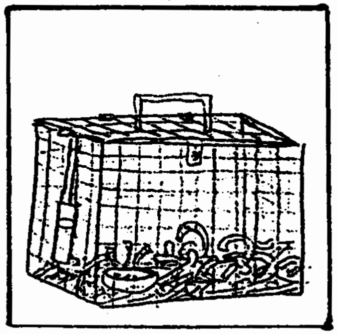
A B C D E

6

A B C D E



7

A

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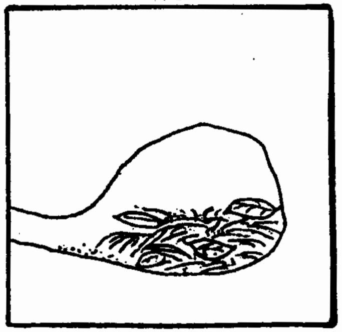
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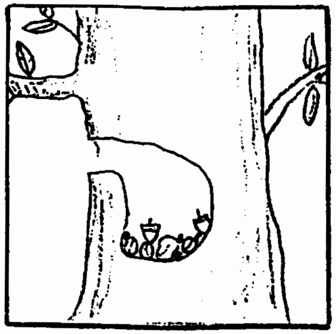
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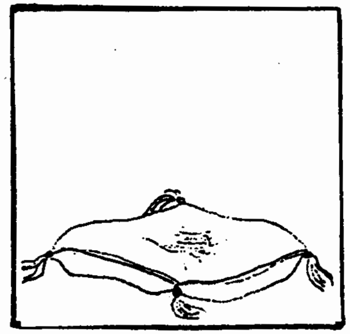
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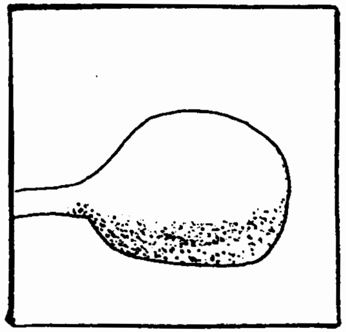
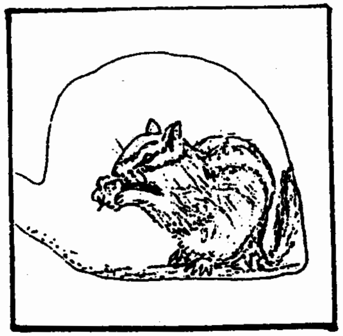


8

A

B

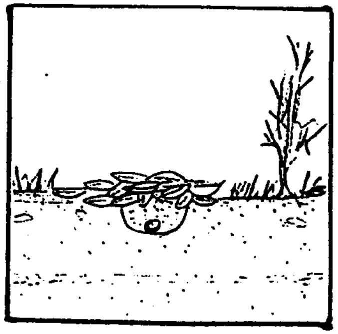
C

D

E


9

A



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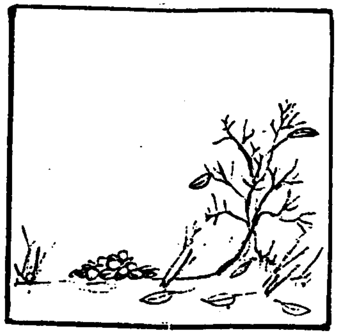
C



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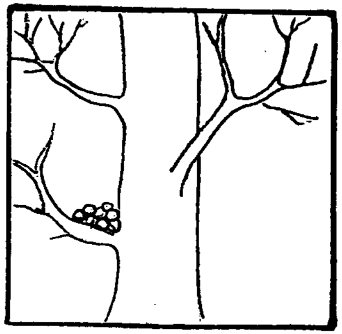

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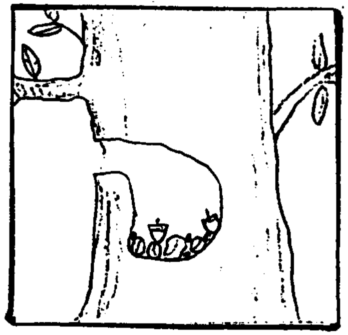
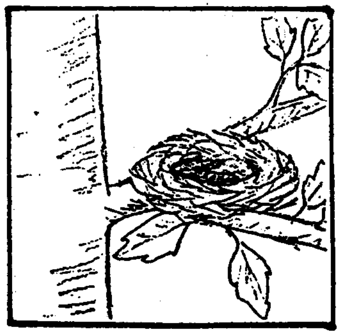


10

A



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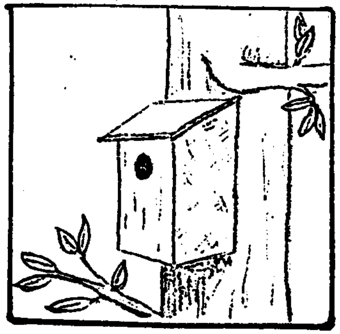

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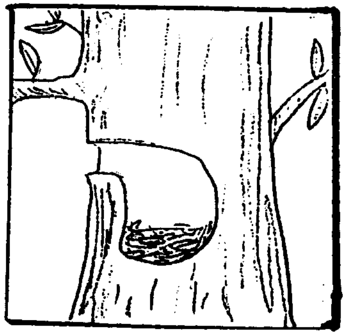

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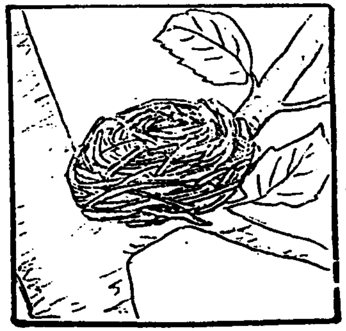
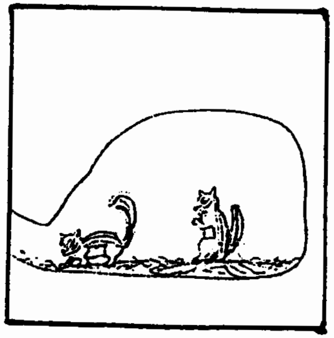


11

A



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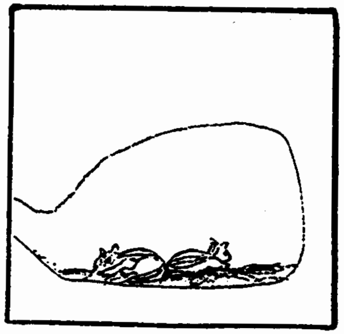

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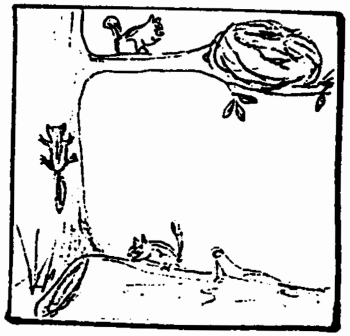
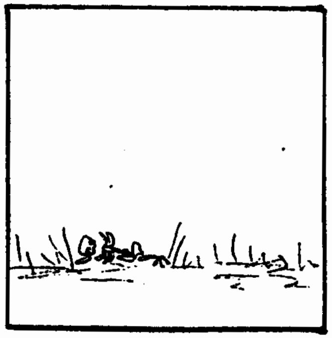


12

A



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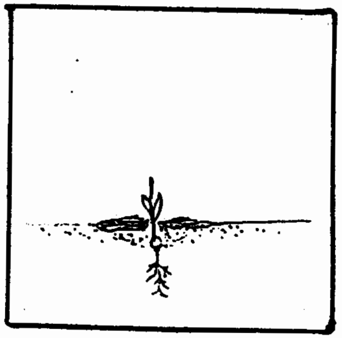

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APPENDIX E

INTRODUCTION SCRIPT

[Seat students. Give them name tags to wear.]

Let me explain a bit about what is going on here today. First, I'll tell you my name. I'm Judy. I'm at your school to do some research. Does anyone know what research is? [responses]

I'm doing some research about learning. I am from Simon Fraser University, and I am trying to find out some things about how people learn. The things I find out might help some students to learn better, and they might help some grown-ups learn to be good teachers. I also brought along a video camera to take some pictures [point]. So, you going to be my helpers today. You are going to help me find out about learning.

Before we start, I have to make sure the camera is set up properly.

[Set camera angles: ALL FACES VISIBLE. Start camera, and check that CAMERA IS ON; MIKE IS ON.]

When I call your name, put your hand up. [Call names.]

Okay, this is what we're going to do today. First I'm going to tell you some things about an animal. When I'm talking, I want you to listen very carefully. [Gesture] Then you will each look at some pictures and try to remember all the things I told you about the animal. Then we will all talk about the animal together. Then each of you will get a chance to talk to me one-at-a-time. You'll get to do some drawing and colouring too. Those are all the things we're going to do in here.

In a minute, I'll start talking about this animal. All you need to do is listen. But first, does anyone have any questions about what we're going to do? [responses.]

Okay, now I'm just about ready to start talking. Let's do it a special way. Let's pretend that I am a world-famous scientist who knows all

about...chipmunks. Here's a picture of one. [Show; hold in front of my face.] And here's another picture of a chipmunk. [Show] Let's pretend I am going to teach you everything I know about chipmunks so you can become chipmunk scientists too. A little later, each of you will have turn to be a chipmunk scientist. But first it's my turn. I'm going to do all the talking, and all you have to do right now is listen very carefully.

Okay, here's the scientist. I'm putting my pretend lab coat on. Hello, children. I'm going to tell you all about chipmunks. [begin lesson]

APPENDIX F

CHIPMUNKS: FAST NONREDUNDANT SCRIPT

Chipmunks Up Close

Think about pictures you have seen of chipmunks and you will remember that a chipmunk has light brown fur, a light belly and a striped back.

The ground squirrel is a close relative of the chipmunk, and it looks a little like a chipmunk too. But if you look closely, you will see that chipmunks have stripes on their faces around their eyes, as well as down their backs. Ground squirrels have plain faces with stripes only on their backs.

Where they live

Most chipmunks live in forests and woods, but some are found at the edge of deserts and high up in the mountains. These places are the same in two important ways. In all of them, chipmunks can find hiding places and the low bushes and plants they need for food.

Chipmunks are ground animals, and all of them spend some part of their life in underground homes called burrows. So it is also very important that they live in a place where the dirt is dry and easy to dig. This means you won't find chipmunks in swampy areas or in places with heavy clay soil.

Usually chipmunks do not live in towns and cities. They are secretive little animals and they hide their homes away.

Chipmunk Homes

Some chipmunks live in their burrows all year, and others for only part of the year. For safety, the chipmunk hides the entrance to its underground home in a brush heap, under a fallen log or at the base of a tree.

Burrows have only one tunnel that leads from the hidden entrance to a den that is about the size of a coconut. The den is the chipmunk's little bedroom. Here the chipmunk makes a bed of shredded leaves, dried grasses and fluffy seed heads. \\ This will make a soft cushion for new babies or a warm bed in which to spend the winter.

Many chipmunks use both an underground den and high-rise nest in a nearby tree. They use the burrow as a winter home and as a home for new babies. They use the tree nest as a summer home. Made of leaves and grasses, the tree nest is shaped like a ball and looks like a covered bird's nest.

A Dangerous Life

Like many small animals, the chipmunk is important to the balance of nature. Animals like coyotes, hawks, weasels, snakes, bobcats and raccoons like to eat chipmunks. The chipmunk hides from these animals by staying near plants or fallen logs that give it cover.

Chipmunks can run quickly, and they are also good swimmers and good climbers. So when a chipmunk is in danger, it quickly dashes away and climbs \\ the nearest tree or scurries into its burrow. The chipmunk avoids most of its enemies this way.

Dinner-time

The types of food that the chipmunk eats will depend on where it lives and the types of food it can find. Summer is the time when there is lots to eat. Their favorite foods include strawberries, blueberries, chokecherries, raspberries, wild grasses and pine seeds.

The chipmunk carries its meal of fruit or nuts up onto a rock or tree stump, or to some other high spot. There it can watch for danger while it has dinner.

Gathering and Storing Food

Chipmunks spend most of their day collecting and storing food. Chipmunks carry food in special pouches in their cheeks. These pouches are not wet like the inside of your mouth. They are dry like your skin, so that the food does not get wet when the chipmunk carries it. The \\ pouches can stretch to carry an amazing number of seeds.

In early summer, chipmunks store food in many different places. They might cover the food with fallen leaves or they might dig small holes and bury it to hide it away. Small seeds are stored in clumps while larger nuts are stored alone.

The chipmunk has good eyesight and a good nose for finding food. It can easily sniff out buried food stores. But it buries so much that the chipmunk might forget where some of the food is hidden and when this happens, the seeds often sprout, growing into plants or even trees. The chipmunk is one of nature's gardeners without even knowing it.

Chipmunk Babies

Baby chipmunks, called pups, are born in an underground den. Usually the mother has about five tiny hairless babies at once that live in her den with her, but all other adult chipmunks \\ live alone. The father chipmunk lives alone in his own burrow.

Like all mothers, the chipmunk takes good care of her babies. She feeds them milk many times a day. She fights any animals that come near her den - including other chipmunks.

Growing Up

After ten days, soft hair covers the pups' bodies and the chipmunk stripes begin to show. The babies open their eyes and begin to walk around the den when they are four weeks old.

Some mother chipmunks move their babies to a tree nest at their fifth week. The new tree nest is roomier and cleaner than the old burrow, and it may also be safer from enemies. The mother chipmunk moves the pups one by one to their new home. As she carries one by the skin of its belly, the baby curls in a tight bundle with its head and tail cuddled around her \\ nose. Soon the young chipmunks will be able to leave the nest and explore.

("\\" indicates one minute intervals)

CHIPMUNKS: FAST REDUNDANT SCRIPT

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Where they live

Most chipmunks live in forests and woods. Most chipmunks live in forests and woods, but some are found at the edge of deserts and high up in the mountains. These places are the same in two important ways. In all of them, chipmunks can find hiding places and \\ the low bushes and plants they need for food.

Chipmunks are ground animals, and all of them spend some part of their life in underground homes called burrows. So it is also very important that they live in a place where the dirt is dry and easy to dig. This means you won't find chipmunks in swampy areas or in places with heavy clay soil.

Usually chipmunks do not live in towns and cities. They are secretive little animals and they hide their homes away.

Chipmunk Homes

Some chipmunks live in their burrows all year, and others for only part of the year. For safety, the chipmunk hides the entrance to its underground home in a brush heap, under a fallen log or at the base of a tree.

Burrows have only one tunnel that leads from the hidden entrance to a den that is about the size of a \\ coconut. Burrows have only one tunnel that leads from the hidden entrance to a den. The den is the chipmunk's little bedroom. Here the chipmunk makes a bed of shredded leaves, dried grasses and fluffy seed heads. The chipmunk makes a bed of shredded leaves, dried grasses and fluffy seed heads. This will make a soft cushion for new babies or a warm bed in which to spend the winter.

Many chipmunks use both an underground den and high-rise nest in a nearby tree. They use the burrow as a winter home and as a home for new babies. They use the tree nest as a summer home. Made of leaves and grasses, the tree nest is shaped like a ball and looks like a covered bird's nest. Made of leaves and grasses, the tree nest is shaped like a ball and looks like a covered bird's nest.

A \\ Dangerous Life

Like many small animals, the chipmunk is important to the balance of nature. Animals like coyotes, hawks, weasels, snakes, bobcats and raccoons like to eat chipmunks. The chipmunk hides from these animals by staying near plants or fallen logs that give it cover.

Chipmunks can run quickly, and they are also good swimmers and good climbers. So when a chipmunk is in danger, it quickly dashes away and climbs the nearest tree or scurries into its burrow. When a chipmunk is in danger, it quickly dashes away and climbs the nearest tree or scurries into its burrow. The chipmunk avoids most of its enemies this way.

Dinner-time

The types of food that the chipmunk eats will depend on where it lives and the types of food it can find. Summer is the time when there is lots to eat. Their favorite foods include strawberries, blueberries, chokecherries, raspberries, \\ wild grasses and pine seeds.

The chipmunk carries its meal of fruit or nuts up onto a rock or tree stump, or to some other high spot. The chipmunk carries its meal of fruit or nuts up onto a rock or tree stump, or to some other high spot. There it can watch for danger while it has dinner.

Gathering and Storing Food

Chipmunks spend most of their day collecting and storing food. Chipmunks carry food in special pouches in their cheeks. Chipmunks carry food in special pouches in their cheeks. These pouches are not wet like the inside of your mouth. They are dry like your skin, so that the food does not get wet when the chipmunk carries it. The pouches can stretch to carry an amazing number of seeds.

In early summer, chipmunks store food in many different places. They might cover the food with fallen leaves \\ or they might dig small holes and bury it to hide it away. They might cover the food with fallen leaves or they might dig small holes and bury it to hide it away. Small seeds are stored in clumps while larger nuts are stored alone.

The chipmunk has good eyesight and a good nose for finding food. It can easily sniff out buried food stores. But it buries so much that the chipmunk might forget where some of the food is hidden and when this happens, the seeds often sprout, growing into plants or even trees. The chipmunk might forget where some of the food is hidden and when this happens, the seeds often sprout, growing into plants or even trees. The chipmunk is one of nature's gardeners without even knowing it.

Chipmunk Babies

Baby chipmunks, called pups, are born in an underground den. Usually the mother has about \\ five tiny hairless babies at once that live in her den with her, but all other adult chipmunks live alone. The mother has about five tiny hairless babies at once that live in her den with her, but all other adult chipmunks live alone. The father chipmunk lives alone in his own burrow.

Like all mothers, the chipmunk takes good care of her babies. She feeds them milk many times a day. She fights any animals that come near her den - including other chipmunks.

Growing Up

After ten days, soft hair covers the pups' bodies and the chipmunk stripes begin to show. The babies open their eyes and begin to walk around the den when they are four weeks old. <u>The babies open their eyes and begin to walk around the den when they are four weeks old</u>.

Some mother chipmunks move their babies to a tree nest at their fifth week. The new tree nest is roomier and cleaner than the old burrow, and it may also be safer from enemies. The mother chipmunk moves the pups one by one to their new home. As she carries one by the skin of its belly, the baby curls in a tight bundle with its head and tail cuddled around her nose. <u>As she carries one by the skin of its belly, the baby curls in a tight bundle with its head and tail cuddled around her nose</u>. Soon the young chipmunks will be able to leave the nest and explore. \\

("\\" indicates one minute intervals)

CHIPMUNKS: SLOW NONREDUNDANT SCRIPT

Chipmunks Up Close

Think about pictures you have seen of chipmunks and you will remember that a chipmunk has light brown fur, a light belly and a striped back.

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Where they live

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Usually chipmunks do not live in towns and cities. They are secretive little animals and they hide their homes away.

Chipmunk Homes

Some chipmunks live in their burrows // all year, and others for only part of the year. For safety, the chipmunk hides the entrance to its underground home in a brush heap, under a fallen log or at the base of a tree.

Burrows have only one tunnel that leads from the hidden entrance to a den that is about the size of a coconut. The den is the chipmunk's little bedroom. Here the chipmunk makes a bed of shredded leaves, dried grasses and fluffy seed heads. This will make a soft cushion for new babies or a warm bed in which to spend the winter.

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Growing Up

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("//" indicates one minute intervals)

APPENDIX G: INSTRUCTIONAL LANGUAGE STUDY

Dear Parent/Guardian:

I am writing to request permission for your son/daughter to participate in a research project as described below.

I am a Ph.D. candidate in Education, and my research study involves an analysis of how characteristics of teachers' instructional language can improve students' success in understanding key ideas in a lesson. The research involves teaching a lesson about a local forest animal and its habitat to small groups of children, then finding out what they learned.

Your child's involvement will include participating with a group of students in the following learning activities: 1) listening to me present a brief lesson about an animal and its habitat; 2) circling pictures to indicate what he/she knows about the animal; 3) talking with other children in a group discussion about the animal; 4) drawing and colouring pictures of the animal; and, 5) talking with me individually about the animal and about whether he/she liked the lesson and found it interesting and understandable. Parts of the above-described activities will be videotaped or audiotaped. These small-group activities will take a maximum of one hour.

Participating children will also complete a brief language screening test administered to the whole class, and their classroom teachers will provide supplementary information about language knowledge and skills.

Strict confidentiality will be maintained in the handling of data and reporting of results to ensure your child's anonymity. Videotapes and other data will be disposed of subsequent to the study according to the university's guidelines for ethical conduct of research.

The study will tke place during May at a time suggested by your child's teacher. Please discuss with your child whether he/she consents to participate, and sign and return the attached page to the classroom teacher this week. If you wish to receive a report about the study, please indicate your name and address, and a report will be mailed at the completion of the study. If you have questions, please phone me at 291-4156 or 291-3395 (messages). Any other issue wish to raise can be registered with Dr. Jaap Tuinmann, Dean of Education, at the number above.

Sincerely,

Judith C. Lapadat
Ph.D. Candidate

April , 1991

INSTRUCTIONAL LANGUAGE STUDY: CONSENT

Date:____________________

I, __________________________________, do give permission for my son/daughter/guardian,____________________________________, to participate in the research study described in the attached letter from Judith Lapadat. I understand that all information about my child will be kept in strictest confidence, and that I can stop my child's participation in the study at any time.

____

(signature of parent/guardian)

....

Name and address (if you wish to receive a report about the project):

Name:____
Address:____
City:____
Postal code:____

April , 1991

INSTRUCTIONAL LANGUAGE STUDY: TEACHER'S CONSENT

Date:__________________

I, ________________________________, agree to participate in the research study described in the attached letter to parents and guardians from Judith Lapadat. I understand my participation will involve distributing and collecting parental consent forms, providing background information related to the students' language knowledge on a checklist, providing not more than one hour of classroom time for a language assessment, and assisting the researcher in developing a mutually convenient schedule for the small group activity. I further understand that all information about the students will be kept in strictest confidence, and that I may withdraw my participation in the study at any time.

____

(teacher's signature)

....

Name and address (if you wish to receive a report about the project):

Name:____
Address:______________________________________
City:____
Postal code:__________________________________

APPENDIX H

DISCUSSION GROUP SCRIPT AND PROMPTS

[Seat students in horseshoe array for discussion; check camera view. Call names - hands up.]

Okay, a few minutes ago, I was pretending to be scientist, and I did lots of talking about chipmunks. Now it's your turn to do some talking. You can each take turns telling your friends about if you ever saw a chipmunk before, and all the things you know about chipmunks and the way they live. You don't need to put your hands up; just talk to each other. While you're talking, I'm going to sit over here and do some writing. _______, you may start.

[Move back; look down at checklist.]

[Fill in checklist. After about 3 minutes, or when conversation drops off, use prompts to complete checklist.]

[....REFER TO CHECKLIST...]

GENERIC PROMPT: [if discussion is off-topic]

Okay, everyone. Remember that you are talking about chipmunks right now.

CHECKLIST PROMPTS: [prompt only topics that don't arise spontaneously. Deliver all necessary prompts for a topic area at once.]

Who can tell the rest/ Who wants to tell everyone...

...about where chipmunks live? [1] What kind of land? [2] What are their underground and [3] tree homes like? [4] What are their beds like?

...about chipmunks' food? [5] How do they carry it? [6] Where do they store it? [7] What if they forget where they stored some? [8] What do they do at dinner time?

...about chipmunk babies? [9] What are newborn chipmunks like and where do they live? [10] What happens when the babies are 4 weeks old? [11] How do chipmunk mothers move the babies?

...what a chipmunk does when it is in danger?

[At approx. 6 minutes:] Okay, let's finish off the discussion. We have time for one more person to say something about chipmunks. [Select a student who hasn't contributed.] ______, would you tell the other students something about chipmunks? [If student declines, select a volunteer.]

Okay, thank-you everyone for sharing all those interesting ideas.

APPENDIX I

School:______________________________ Date:__________

Condition:____________________________

DISCUSSION GROUP CHECKLIST

During discussion, tally comments on each listed topic. After approx. 3 minutes begin prompting ONLY for topics that haven't been spontaneously addressed (either correctly or incorrectly). Prompt each topic only once. Continue to tally comments after prompt.

Codes:
/ = spontaneous; correct
X = spontaneous; incorrect
? = spontaneous; on-topic; accuracy uncodable
P = prompt
+ = correct after prompt
- = incorrect after prompt

HOMES
1. Chipmunk's habitat
2. What the burrow is like
3. Chipmunk's tree home
4. Chipmunk's bed

FOOD
5. How they carry food
6. Storing food for winter
7. Forgets where food is
8. Chipmunk's dinner time

BABIES
9. What babies are like
10. Babies' fourth week
11. How mothers move babies

DANGER
12. What chipmunk does

APPENDIX J

INDIVIDUAL INTERVIEWS SCRIPT

Now it's time for you all to have turns being chipmunk scientists. While one person is having a turn, everybody else can draw and colour pictures. Then another person can have a turn.

[Turn camera off. Rearrange seating if needed. Hand out paper, pencils, and markers.]

We have been talking about chipmunks, so make a picture about chipmunks. Draw a picture about chipmunks and the way they live, or make up a story or an adventure about chipmunks, and do a picture of it. Any questions?

....

______, could you come with me please? Okay, you get to be a chipmunk scientist now. [Turn tape recorder on. Check student's name on list.]

Okay, here's _____, the chipmunk scientist. Let's pretend I don't know very much about chipmunks, and you know lots. You're going to teach me everything you know about chipmunks. You can start talking now. Tell me all about chipmunks and the way they live.

[If student has trouble starting:] Okay, start by telling me what they look like.

[Encourage, nod, acknowledge. Repeat back unclear portions; describe visual gestures]

Good; what else can you you tell me about chipmunks? / Can you think of anything else? [Keep prompting until no new ideas are forthcoming.]

Thank-you chipmunk scientist. Before you go and work on your picture, I want to ask you a few questions. [Metapragmatic probe.]

1. When I was pretending to be the chipmunk scientist a little while ago, I was talking a special way. What was special about the way I talked?

2. Do you think I was talking fast, slow, or medium?

3. Do you think I repeated things a lot, hardly at all, or about medium?

4. When I was being the chipmunk scientist, do you think my lesson about chipmunks was hard to understand, easy to understand, or about medium?

5. What things did I do to make the lesson hard to understand?

6. What things did I do to make the lesson easy to understand?

7. Of all the things we did in here today, what helped you learn the most about chipmunks?

8. What things should I do to make the lesson better next time?

Okay, thank-you for noticing all those things. Now you can go and work on your chipmunk picture.

[Repeat with next student.]

APPENDIX K: VERBAL PROTOCOL: TRANSCRIPTION CODES

Student

Students' statements are transcribed in full, word-for-word, and punctuated according to intonation. In addition, the following codes are used.

( ) uncertain portion of transcription

[ ] phonetic transcription; meaning unknown

X unintelligible syllable; both sound and meaning not heard

- long pause

Interviewer

All of the interviewer's remarks are indicated in square brackets [ ]. The interviewer's remarks are not transcribed unless necessary to interpret the student's meaning. Instead the following codes are used for the interviewer's utterances.

IN introductory remarks

END ending remarks

TRAN transition to next activity

OK acknowledgement

R repetition of student's utterance

P prompt (for further information)

C request for clarification

ANS answer to a student's question

RE instruction, reinstruction, guiding comment, or repetition of question

Other

Other codes are used to indicate unrelated talk which occurs during the interview audiotaping.

CONV prior unrelated conversation

MAN remarks directed to other students for the purpose of managing behavior

APPENDIX L

VERBAL PROTOCOL: CODING PROTOCOL

From the verbal protocol transcriptions, identify "facts" and "misconceptions" that the students expresses.

<u>Facts</u>

Underline in green each fact that was presented in the lesson that is verbally recalled by a student. Each fact is assigned 1 point. The following guidelines define what is construed as a "fact."

- If a fact is mentioned more than once, it only gets a point for the first mention, although it should be underlined each time.

- Responses that are so vague or general that they could apply to almost any animal do <u>not</u> get a point, nor are they underlined (e.g. "They carry food." "They put food in their mouth."). The remark, "they live in trees," is not considered a fact unless the student clarifies, in at least way, the circumstances in which chipmunks live in trees.

- Responses that are true, but were not mentioned in the lesson do <u>not</u> get a point (e.g. "They are mammals.").

- Each main idea is counted as a fact, even if there are several in a sentence (e.g. "They have stripes on their back and stripes on their face": 2 facts).

- If a student later recalls some additional facts about chipmunks during the "metapragmatic probe" portion of the interview, these facts are also underlined and counted.

<u>Misconceptions</u>

Underline in purple each misconception. Do not assign points.

- If a claim is unusual but plausible, it is not counted as a misconception (e.g. PLAUSIBLE: "A chipmunk ate some popcorn from my hand." MISCONCEPTION: "Chipmunks mostly eat popcorn.").

- If a series of remarks are fantastical or narrative in form, code implausible claims as misconceptions, and also flag these protocols with a red * in the top right corner of the page.

- Don't code a claim as a misconception on the basis of misuse or atypical use of a word if the child's intent and grasp of the content is clear from the surrounding text.

APPENDIX M

DESCRIPTION OF OUTLYING CASES OMITTED FROM MANCOVA

The first outlying case was a very active boy in the fast, nonredundant condition (Condition 1) who paid little attention to the chipmunk lesson. His standardized residual for Attention (obtained through residual analysis of an omnibus MANCOVA including all cases) was -3.31 (percent attention was 12.0). His Picture Task score was also markedly depressed (Picture Task score = 1 out of 12) with a standardized residual of -2.57, but his *TOLD* and Verbal Recall scores were within normal range. He was 7-10 years old, in grade two, and identified by his teacher as having average language abilities and no special learning needs.

The other three outlying cases each recalled an unusually high number of facts about chipmunks in the verbal protocol. One of these students, a girl, was in the same group of six students as the first outlier. Her Verbal Recall score was 25, as compared with a mean of 7.19 (standardized residual = 3.36). She was 7-9 years old, in grade two, and also identified by her teacher as having average language ability and no special learning needs.

Another outlier was a boy, aged 7-9 in grade two, who was in the slow redundant condition. He obtained a Verbal Recall score of 26 (standardized residual = 3.22). He was identified by his teacher as having high language ability and no special learning needs.

The third student, was only identified as an outlier once the previous three cases were omitted. He was a boy, aged 7-8 in grade two, who was in the fast, redundant condition. He obtained a Verbal Recall score of 23 (standardized residual with $n = 111$ was 3.15). This boy was identified by his teacher as having high language ability and no special learning need. None of these three students exhibited unusual *TOLD*, Attention, or Picture Task scores.