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ABSTRACT

A study used causal modeling to examine how second-grade students' language ability interacted with two characteristics of a teacher's language during naturalistic expository instruction to explain students' attention to and learning from a science lesson. Subjects, 120 students from 13 suburban classrooms, working with an instructor in groups of 6, listened to a 6-10 minute lesson about chipmunks. Each group heard instructional language that was fast and nonredundant, fast and redundant, slow and nonredundant, or slow and redundant. Results indicated that a significant portion of the variance in learning outcome on two measures, a multiple choice picture task and a verbal recall task, was explained by prior language ability and pace of the instructional language, mediated by students' attention to the lesson. Special needs students exhibited a different pattern of learning and attending than "regular" students. They attended to fast-paced instruction as much as regular students and learned as much. But when instructional language was slow-paced, special needs students attended less and learned less than regular students. The special needs students' different attentional and learning patterns could be attributed to attentional deficits, comprehension monitoring deficits, or to these students making different choices about how to allocate their resources. Findings suggest that teachers ought to modify their instructional language for students, and that how they do this will depend on students, teachers' instructional goals, the instructional processes they use, and their beliefs about the aims of education. (Contains 26 references, and 7 tables and 12 figures of data.) (Author/RS)

Teachers Talking and Students Listening:

A Model of Learning Outcomes

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Running Head: TEACHERS TALKING

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Abstract

This study used causal modelling to examine how second grade students' language ability interacted with two characteristics of a teacher's language during naturalistic expository instruction to explain students' attention to and learning from a science lesson. One hundred and twenty students from thirteen suburban classrooms, working with an instructor in groups of six, listened to a six to ten minute lesson about chipmunks. Each group heard instructional language that was fast and nonredundant, fast and redundant, slow and nonredundant, or slow and redundant. Results were that a significant portion of the variance in learning outcome on two measures, a multiple choice picture task and a verbal recall task, was explained by prior language ability and pace of the instructional language, mediated by students' attention to the lesson. Special needs students exhibited a different pattern of learning and attending than "regular" students. They attended to fast-paced instruction as much as regular students and learned as much. But when instructional language was slow-paced, special needs students attended less and learned less than regular students. The special needs students' different attentional and learning patterns could be attributed to attentional deficits, comprehension monitoring deficits, or to these students making different choices about how to allocate their resources. These findings suggest that teachers ought to modify their instructional language for students, and that how they do this will depend not only on the students, but also on those teachers' instructional goals, the kinds of instructional processes they use, and their beliefs about the aims of education.

Teachers talking and students listening:

A model of learning outcomes

Teachers and students bring many kinds of knowledge, including experiential knowledge, schematic knowledge, strategic knowledge, social knowledge, and linguistic knowledge to any instructional task (Kamhi & Catts, 1989). When we examine how language is linked to students' academic learning, two important domains of language to consider include students' linguistic knowledge and teachers' use of instructional language. These influence and are situated within classroom processes, including instructional, discourse, and social processes.

Students' language knowledge can be conceptualized as including receptive language knowledge (ability to understand what is said and read) and expressive language knowledge (ability to convey meaning through spoken and written language). Receptive and expressive knowledge includes syntactic, morphological, semantic, phonological, pragmatic, orthographic, and metalinguistic levels of knowledge of spoken, written, and nonverbal language within a multiplicity contexts. Language knowledge is complex, interconnected, situated in context, and changes over time, thus is hard to describe quantitatively or qualitatively. However, it is important to investigate students' receptive and expressive language knowledge as it influences how students understand, participate in, and learn from the interactions that comprise instruction (Roth & Spekman, 1989).

The ways teachers talk interact with the language knowledge students bring to learning to influence classroom processes and learning outcomes. One of the important things young students need to do in order to learn in school is understand what teachers say. One of the things teachers need to do in order to teach effectively is talk so that their students can understand. If students fail to have sufficient linguistic knowledge to understand, or if teachers fail to adjust their instructional language, the complexity of the instruction might adversely affect academic learning.

In order to adjust their instructional language to their students' communicative needs, teachers need to know what ways of talking will help students understand and learn, and how this will vary for different students, materials, learning activities, and situations. Students need to provide feedback to teachers about what they are thinking as the teacher teaches. Talking is one important way to do this and writing is another. The teacher needs to interpret this feedback in order to understand how to adjust his or her instruction, including use of 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 information processing task for students.[1] Teachers can use more 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 (Carlsen, 1991; Winne, 1979). They can use highly concrete, imaginal examples, or abstract verbal elaborations (Lapadat & Martin, in press; Martin, 1993; Paivio, 1986). They might 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).

[1]Here I am focusing on expository instruction, in which teachers do most of the talking, and students listen. This is, of course, only one of many kinds of instructional interchange that one finds in classrooms. As expository instruction is particularly pervasive, it is all the more important to do it well when it is called for. Teachers also need to strive to replace much teacher-dominated discourse with other productive forms of instructional interchange.

Examined within an information processing model of learning and memory at a micro-instructional level, even selected aspects of classroom language have important implications for how students learn. For example, an information processing model would predict that pace and redundancy of instructional language would influence complexity of the information processing task. Short term (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 slowly can result in bits being lost before all the necessary bits are available to be assembled for any particular idea. Increasing the redundancy of presented information 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, therefore, is predicted to produce the "easiest" listening task, while increasing pace or reducing redundancy makes the listening task harder.

What makes language easier or harder for listeners to understand depends on both the characteristics of the message as expressed by the speaker, and the linguistic capabilities of the listener. 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.

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 selectively 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.

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 selectivity of attention, and how this depends on individuals:

> 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." Subsequently, behaviorists defined attention as a passive receptive mechanism that could be manipulated so that external stimuli or information could be transmitted more efficiently.

These perspectives of attention now are giving ground to more cognitive explanations, in which students are seen as active learners who cognitively construct knowledge within social contexts. 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 learners, and only the information to which they attend can be learned.

What learners attend to is a function of both their internal cognitive processes and resources, and 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, and mands (Gage & Berliner, 1979). Cognitive research is complemented by sociolinguistic and ethnographic research, which has focused more on social correlates of attention such as what student 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).

Several themes can be identified in recent empirical research on the relationships between instructional presentation, complexity or difficulty, attention, and comprehension or learning (see Lapadat, 1993, for a review). Issues studied include: whether predisposition to pay attention is a predictor of children's learning difficulties in general; what aspects of instructional presentation predict high levels of attention for young learners; the complicated links between instructional presentation, complexity of the content, attention, and learning outcome; and methodological problems measuring 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 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.

Few of these studies have examined the relationship between attention, instructional language, and learning within naturalistic instruction. In classrooms in which teachers teach by talking, either a lot or a little, we can wonder to what extent particular students attend to that talk, and what characteristics of the teachers' talk elicit greater attention, and whether greater attention yields more learning.

The purpose of this study was to test a causal model linking aspects of young students' language ability,[2] characteristics of teachers' instructional language, and a process variable reflecting students' ongoing engagement in the instructional activity, with

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[2]or English language proficncy, for those students learning English as a second language.

measures of students' learning. Another goal was to explore how relationships between instructional language, understanding, engagement in learning, and final content knowledge differ for students with special needs.

In order to examine how students' knowledge of language and teachers' use of language during instruction interact to explain students' attention to and learning from an expository lesson, the following questions were posed. To what extent is students' learning explained by their language ability? Do pace of presentation or redundancy of key ideas in a lesson explain students' learning outcomes? How do these two instructional language variables (pace and redundancy) interact with respect to students' learning outcomes, and how does this vary depending on students' language abilities or learning needs? Does amount of attention students give to the lesson differ depending on language ability, special needs status, pace or redundancy of the instructional language, or some combination of these? Does attention mediate between the predictors of language ability and instructional language characteristics on the one hand, and learning on the other? Finally, are these relationships similar for those students with and without special needs?

A causal model representing links between students' language ability, two characteristics of teachers' language in a lesson, students' attention, and two measures of learning was postulated. This article reports an exploratory test of this causal model (see figure 1).

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insert figure 1 about here

Method

Participants

Participants included 120 boys and girls from 13 grade 2 (or combined grades 1-2 or 2-3) classrooms in 5 suburban schools. They ranged in age from 6-4 to 9-11 years. All consenting grade 2 students in participating classrooms 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.[3]

insert table 1 about here

Each student's language ability was rated by his or her teacher as high, average, or low. The teachers also identified students who had, in their view, any of the following special learning needs: English as a second language, learning disability, behavior disorder, mental handicap, speech or language disorder, or other. If they indicated "other," they were asked to specify the student's special need (hearing impairment, giftedness, and so forth).[4] In addition, the researcher administered the receptive

3One school had insufficient volunteers to form four groups, thus 18 students participated in three groups. Another school contributed an extra fifth group which completed the missed condition.

4As 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 the researcher was able to consider possible special learning needs of students who, at this age, might not yet have been formally identified as having special needs.

vocabulary subtest of the Test of Language Development (TOLD) to all participants to provide another indicator of language ability (or English language proficiency).[5]

Procedures

Students worked with the researcher, an experienced instructor, in groups of six in a school resource room. They listened to the instructor deliver a spoken[6] six to ten minute lesson about chipmunks in one of four instructional language conditions. Content for the lesson about the life and habitat of chipmunks was adapted from two sources (Audubon Nature Encyclopedia; and Switzer, 1985).

The instructor systematically varied two levels of pace and redundancy of the instructional language to produce a fast nonredundant, fast redundant, slow nonredundant, or slow redundant version of the lesson for each condition, while retaining identical lesson content across conditions. Fast pace was defined as a speech rate of 150 words per minute, and slow pace was defined as a speech rate of 120 words per minute (cf. Smith & Land, 1981, who reported the average rate of teacher talk to be 130 words per minute). Redundancy was defined as the verbatim repetition of key ideas immediately after their first mention. For each of twelve key ideas, the content necessary to identify the target picture correctly in a subsequent multiple-choice picture task was the information repeated

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[5]This was not administered at the time of the data collection, but on a separate visit.

[6]without accompanying visual materials. Visual confounds were avoided to 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.

in the redundant conditions. The redundant lessons included these repetitions of twelve key ideas, and the nonredundant lessons did not.[7]

Students were videotaped during the lesson. A video camera located behind the instructor's head recorded the students' gaze at the instructor. A measure of attention during the lesson was obtained for each student by calculating percent of visual orientation to the instructor.

Two measures of students' learning were used. Students completed a multiple-choice task presented in pictorial format[8] immediately after the lesson. Then, following group discussion and a drawing activity, verbal recall was assessed in an individual interview with the researcher.

The multiple-choice picture task tested the children's memory of twelve key ideas that had been presented in the lesson. For each item in the Picture Task booklet, participants marked one of five pictures in response to a verbal cue. Incorrect alternatives represented misconceptions about chipmunks commonly held at this age, or misconceptions that might typically arise from incomplete comprehension of the lesson.[9] Participants were trained on the answering procedure prior to test administration. Each correct answer scored 1, and incorrect answers scored 0, for a maximum total of 12.

In the individual interview, students first talked about "everything" they knew about chipmunks (verbal protocol), and then answered questions about the instructional

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[7] Scripts for the four versions of the chipmunk lesson and the introduction to the lesson are available from the author on request.

[8] The multiple-choice picture test, with instructions and scoring protocol, is available from the author on request. Pictures were used as many of the children were not yet proficient readers.

[9] Details about the development of this test, and measures of its reliability and validity, have been reported elsewhere (Lapadat, 1993).

language and tasks (metapragmatic probe)[10]. These interviews were audiotaped. The verbal recall score, which was calculated from the verbal protocol, 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 recall. 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.

Each session lasted about an hour. The procedure described above was the same for each of the four conditions (twenty groups).

Data Coding and Scoring

The language test was scored according to the published instructions for scoring the receptive vocabulary subtest of the TOLD. Raw test scores (number of items correct out of 25), rather than language quotient, were used in the analyses because the students' variations in age. As described above, the multiple-choice picture task was simply scored out of twelve. However, the coding and scoring of attention and verbal recall were rather more complex.

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 by the researcher using computer software developed for this purpose.[11]

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[10]The videotaped group discussions, the students' drawings, and the audiotaped metapragmatic probe data were not analyzed as part of this study, thus will not be discussed further here.

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

The coder viewed the videotape, observing one of the six students 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, an auditory marker was placed at each sentence boundary in the videotape of each lesson. (This marker was placed on the 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.[12] For each student and for each sentence in the lesson, a record was obtained 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,

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[12] 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.

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.

The researcher coded attention 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 $r = .94$.

Verbal protocol. The first step in coding the audiotaped interview data (verbal protocols) involved transcribing word-for-word what each student said. The transcripts were then coded by underlining each true[13] 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, or vague or general statements that could be true of most animals, uninterpretable statements, and fantastical narrations were not counted. The total number of true statements about chipmunks was tallied, and provided the verbal recall score for each student used in subsequent analyses.[14]

The researcher 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 both coders identified as facts), 8 "misses" (statements the coder identified as facts but the recoder did not), and 1 "intrusion" (a statement the recoder identified as a fact but the coder did not). Coder agreement was 86%.

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[13]According to the researcher's judgment, with use of reference materials when uncertain.

[14]The coding protocol is available from the author on request.

Results

Six variables were used in the multiple regression analyses for causal modelling.[15] Four of these variables were continuous, including TOLD, Attention, Picture Task, and Verbal Recall.

TOLD, an indicator of language ability, was an exogenous variable in the path analysis. Attention, a process (mediating) variable reflecting students' engagement as they listened to the chipmunk lesson, was analyzed as an endogenous variable in the path analysis. The Picture Task, a measure of students' recall of twelve key facts immediately after listening to the chipmunk lesson, was a second endogenous variable in the path analysis. The Verbal Recall score, which represented the total number of facts about chipmunks students expressed in the individual interview, was the final outcome measure following all of the instructional activities. It was the final endogenous variable in the path analysis.

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.

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[15] A Multivariate Analysis of Covariance (MANCOVA) for comparison of means was also conducted. As the results supported the path analytic findings reported here, without adding substantive new information, they will not be discussed further here. Consult Lapadat (1993) for further discussion.

Preliminary Descriptive, Correlational, and Univariate Analyses

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 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.[16]

insert table 2 about here

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.

insert table 3 about here

A one-way analysis of variance (ANOVA) of TOLD by Condition did not detect statistically significant differences, $F(3, 116) = 0.55$, $p = .64$. As students were randomly assigned to treatment conditions, TOLD scores were not expected 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 significant main effect for Pace, $F(1, 116) = 6.48$, $p \leq .01$, but neither the main effect for

[16]One-way ANOVAs of TOLD, Attention, Picture Task and Verbal Recall scores by grade then by age showed no statistically significant differences by grade or age for any of these variables.

Redundancy nor the Pace by Redundancy interaction were statistically significant. 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 significant main effects for Pace or Redundancy, but the Pace by Redundancy interaction was statistically significant, $F(1, 116) = 6.29$, $p \leq .01$. 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 redundant condition, but lowest of all in the fast nonredundant condition (see Figure 2).

insert figure 2 about here

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 significant for either main effects or the interaction, as shown in a two-way ANOVA (see Figure 2).

Characteristics of students with special learning needs. Out of 120 students, teachers identified 3 (2.5 %) as Gifted. The following special learning needs were also identified: English as a Second Language (n = 12), Learning Disability (n = 10), Mental Handicap (n = 1), Behavior Disorder or Emotional Disturbance (n = 4), Speech or Language Disorder (n = 9), and Other Special Need (n = 3).[17] In all, 30 students (25 %) were identified as having special needs other than giftedness.[18] As there were too few students in each category for statistical analysis, further analyses were conducted on one combined Special Needs group (omitting the Gifted students). 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 TOLD, Attention, Picture Task, and Verbal Recall, a not unexpected pattern is seen (see Table 4). Special Needs students obtained lower mean scores on each measure than did Regular students. The 3 Gifted students obtained higher mean scores on the TOLD, Attention, and Picture Task measures and a higher median score (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

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17One of these students identified himself as hearing impaired to me, but was not identified as having a special need by his teacher.

18Some students were identified as having more than one special need, and this is why the preceding ns do not sum to 30.

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 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).

insert table 4 about here

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 5, Table 6, and Figure 3).

insert table 5 about here

insert table 6 about here

insert figure 3 about here

As can be seen in Table 5, 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 6, 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 4. (Median rather than mean scores are displayed in figures 3 -- 6, as the median is less influenced by violation of normality and outliers than is the mean.)

insert figure 4 about here

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 ($\underline{M}$ = 7.0; $\underline{Md}$ = 8.0). Special Needs students, as a group, scored highest on the Picture Task in the fast redundant condition ($\underline{M}$ = 6.0; $\underline{Md}$ = 7.0). These results are displayed in Table 5, Table 6, and Figure 5.

insert figure 5 about here

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 6).

insert figure 6 about here

Correlations. The correlation matrix in Table 7 includes the main variables Pace, Redundancy, TOLD, Attention, Picture Task, and Verbal Recall, as well as 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 special learning needs, 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. 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).

insert table 7 about here

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. On viewing the attention videotapes, 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, peer attention was calculated 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.

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 students paying less attention to the lesson. Pace was not significantly correlated with either of the outcome variables, Picture Task or Verbal Recall. Redundancy was not significantly 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 significantly correlated with both learning outcome measures, Picture Task, and Verbal Recall. Percent attention was significantly correlated with both outcome measures. The two learning outcome measures were also significantly correlated These correlations between the main variables, excepting the nonsignificant correlations for Redundancy, were consistent with the theoretical model postulated, and supported proceeding with the multiple regression analysis to test the hypothesized causal model.

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.

However, Special Needs was significantly 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 special learning needs. These results are consistent with widely accepted findings from 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 significantly correlated with TOLD scores ($r = .42$; $p \leq .001$). This also supports the validity of TOLD as a language measure for these students, and is indicative of these teachers' abilities to judge the language skills of their students.

Peer Attention was significantly correlated with Attention, suggesting a relationship between individual attention and degree of attention of peers in the group. (Of course, 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.

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 as planned. In addition, validity of the measures chosen was supported. Furthermore, some additional variables of interest (Special Needs and Peer Attention), were identified for inclusion in alternative path models.

Path Analyses

First, the path model obtained by testing the theoretical model postulated prior to collecting the data is presented. Then 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 are presented.

Theoretical model. The theoretical model 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 7, 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 significant 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 ($p \leq .001$).

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insert figure 7 about here

Several statistically significant direct effects of prior variables on subsequent variables are also shown in this model (Figure 7). 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 nonsignificant path coefficients suggest that theory trimming is in order. In particular, Redundancy seems to be unneccesary in this causal model. Finally, the statistically significant R^2 values for each of the endogenous variables (Attention, Picture Task and Verbal Recall) and the several statistically significant 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 significant relationships remained in the model. As can be seen in the graphic representation of the theory trimmed model, Figure 8, this yielded negligible increases in the error terms, and highly significant R^2s.

insert figure 8 about here

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 8. This model was judged the strongest representation of the inferred causal links between the original variables selected for inclusion.

Alternative 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 measured confidently (Kleinbaum, Kupper, & Muller, 1988).

Figure 9 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).

insert figure 9 about here

Models for the fast nonredundant and the fast redundant lessons were consistent with the postulated causal structure (although both must be interpreted cautiously due to small sample size). 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 significant role in either model, and in Condition 4 (slow redundant instructional language), the only significant 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, significantly 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, conditions were combined to derive a fast-paced model and a slow-paced model (Figure 10). 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 nonsignificant paths were set to zero in turn.

insert figure 10 about here

As can be seen in Figure 10, 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, 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 was the only variable to have a statistically significant effect.

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.

As this model was developed post hoc based on patterns observed in the data, it cannot be seen as a test of the tenability of theoretically derived causal links. Rather, it represents theoretically plausible relationships between sequential variables for future testing on a different data set. As it includes variables not originally included in the theoretical model, this alternative model suggests directions to follow in rethinking the possible causal relationships in this type of school learning.

Special Needs was viewed as an exogenous variable partially explaining TOLD, because learning English as a second language, having a speech and language disorder, or having a learning disability could logically be expected to predict a student's score on a test of receptive vocabulary. Thus, Special Needs was considered to be logically prior to TOLD.

In contrast, Peer Attention was seen as mediating students' attention to the lesson. 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 significantly in the original model. The hypothesized causal model containing Special Needs and Peer Attention is shown in Figure 11.

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insert figure 11 about here

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 12 shows the theory-trimmed causal model including Peer Attention and Special Needs. A hierarchical approach to regression was used. Clearly, adding these two variables to the model explained some of the previously unaccounted for variance in Attention and Verbal Recall, but the $\underline{R}^2$ for Picture Task was essentially unchanged. Special Needs has statistically significant direct effects on TOLD, Attention, and Verbal Recall, showing that Regular students had higher language ability scores, attended more to the lesson, and recalled more facts about chipmunks in the individual interviews than Special Needs students. Peer Attention has significant direct effects on Attention and Verbal Recall, showing that an individual student's attention is partially explained by the amount peers attended to the lesson.

insert figure 12 about here

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 second grade 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 Special Needs was coded 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, and separate models can be derived for each different special learning need.

<u>Results Summarized in Terms of Initial Research Questions</u>

The findings in brief, as related to the original research questions are as follows. Language ability/English language proficiency as measured by the TOLD subtest of receptive vocabulary or by teachers' judgments consistently showed a strong positive relationship to measures of students' learning outcome following the chipmunk lesson.

Overall, slower pace of presentation was related to higher outcome scores, especially on the multiple-choice Picture Task, regardless of students' initial language levels. However, students with special learning needs who heard slow-paced instructional language tended perform less well on outcome tasks than special needs students who heard fast-paced instruction. Learners with special needs performed similarly to regular peers in fast-paced conditions, but much below regular peers in slow-paced conditions, especially on verbal recall.

Redundancy did not have a main effect in explaining learning outcome, but there was a significant interaction with pace. 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 students with special needs obtained their <u>lowest</u> verbal recall scores in the slow redundant condition.

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 was not significantly related 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.

Attention was found to mediate between pace and redundancy of instructional language on the one hand, and students' learning outcomes on the other. While both attention and slow pace were positively related to 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 gains. But for special needs learners, the decrease in attention was considerable, and was matched by a corresponding decrease in learning outcome scores.

Discussion

Findings of this study, on the whole, confirmed the postulated causal model. Pace, and in some conditions, redundancy of instructional language were shown to explain a significant amount of the variance in second grade students' attention to expository instruction. Language ability, pace and redundancy of instructional language, and attention to the lesson explained a significant amount of the variance in students' learning outcomes as measured in two ways. Two additional variables derived post hoc, special needs status and peers' attention, also explained a significant amount of the variance in the students' attention and learning outcome scores. Finally, interesting differences between regular and special needs students in their attention to different kinds of instructional language, and subsequent learning outcomes were identified.

One of the most interesting findings of this study concerned the mediating role played by attention. Across the full sample, while slow-paced instructional language and high levels of attention were both positively related to learning outcomes, on average students attended less to slow-paced instruction. Thus students obtained their highest scores on the multiple-choice picture task when they heard either a fast but redundant lesson or a slow but nonredundant lesson, lower scores in the slow redundant condition, and their lowest scores in the fast nonredundant condition. (A similar pattern of effects for verbal recall was not statistically significant.) While the slow redundant language condition could be seen as the "easiest" learning condition in terms of information processing demands, students did not achieve their best learning outcomes in this condition. Their outcomes were mediated by the amount of attention they directed to the lesson.

When students identified by their teachers as having special learning needs were examined separately from regular students, markedly different patterns were found. Students with special needs attended most and obtained their best learning outcomes (equivalent to those of regular students) in fast-paced conditions, but both attention and learning declined as pace was slowed and redundancies were added. In contrast, regular students' attention dropped only slightly as pace was slowed and redundancies were added, and their learning outcomes increased. The differences between regular and special needs students were most dramatic on the verbal recall task.

These findings about learning differences of students with special needs are consistent with either a cognitive deficit explanation or a cognitive resource allocation explanation. The evidence that special needs learners attend less, on average, than regular learners to instruction, and especially that they attend less to instruction that is slow-paced, or both slow-paced and redundant, than to fast-paced instructional language could be interpreted as indicating that these students with special needs had attentional deficits.

They did not sustain attention to the listening task unless the inputs were rapid and constantly changing.

Attentional deficits are commonly found in learning disabilities research; in fact, in many widely accepted conceptualizations of "learning disability," a deficit in sustained attention is one of the defining characteristics. However, the students identified as having special learning needs in this study were not confined to students with learning disabilities. They also included students with speech or language disorders, behavioral or emotional disorders, intellectual handicaps, and students learning English as a second language.

A comprehension monitoring deficit is another kind of cognitive deficit that could account for these learning differences between special needs and regular learners. As students listen to instructional language, presumably they monitor their understanding of what is said in order to guide the way they direct their attention, or to determine whether they need to employ other learning strategies to help them understand. These results suggest that, rather than monitoring their comprehension level, perhaps the students with special learning needs used external cues like pace and redundancy of the instructional language to decide whether a listening task was "hard" or "easy," and thus whether they needed to pay attention. Therefore, they attended less to slow instructional language, especially if it also was redundant. However, the chipmunk lesson presented complex ideas and many unfamiliar facts, and comprehension posed a challenging task for the students in all of the instructional language conditions. Had students with special needs monitored their comprehension effectively, they ought to have attended well in all the instructional language conditions -- just as their regular peers did.

An alternative explanation for the learning differences between regular and special needs learners is that rather than having cognitive deficits, perhaps the special needs students simply made different choices about how to allocate their cognitive resources. At any moment, for any listener, there are many events and internal thoughts competing for attention. Participants in this study were told that they needed to listen carefully to the chipmunk lesson, and that they would be asked what they knew about chipmunks afterwards. Yet, for whatever reasons, perhaps these special needs learners were willing to accept a lower payoff in terms of learning about chipmunks in order to be free to direct some of their attention elsewhere. In fact, this strategy was fairly efficient for their learning outcomes in the highly structured multiple-choice picture task. But it was not efficient in the open-ended verbal recall task, and large differences in learning outcomes between regular and special needs learners were observed.

In future research, it would be interesting to examine factors such as students' beliefs, goals, values, and achievement motivation in similar learning situations, perhaps through the use of interviews, in order to clarify whether these learning differences can be explained best as deficits, or as the result of students making different choices. Whether we explain these differences in attentional processes and learning outcomes as being deficits or as due to experiential or motivational differences influencing special needs students' way of participating in the "game of schooling" has implications for how we promote learning among diverse students.

Additional variables to consider investigating within this sort of model in future research include students' prior knowledge about the subject domain, motivational aspects such as interest and expectations, and other contextual and constructional process variables. This model could also be tested with different categories of special needs students, and with different age groups.

These findings have three main implications for theory and methodology. First, the results support a view of learning as arising through classroom interactions. Secondly, some of the causal links between interactional variables in this particular instructional situation were unpacked, showing that causal modelling can be a useful way to find out about relationships of variables in naturalistic learning contexts. Finally, however, is the caution that it is not possible to capture the complexity of the many variables and relationships within-context and across time in naturalistic teaching and learning in classrooms using "closed systems" like fully-specified causal models. Thus, this sort of quantitative analysis is exploratory rather than confirmatory, and complements rather than substitutes for the rich qualitative analyses of sociolinguistic and ethnographic classroom research.

Several instructional implications arise from these findings. One obvious implication is that it matters how teachers talk. The "common sense" heuristic of speaking more slowly and redundantly to special needs learners to help them understand was counter-productive. These students actually attended less and learned less from slow redundant instructional language, although their regular peers benefitted.

Thus, it would seem useful for teachers to become aware of the pace and redundancy of their instructional language, how these might differentially affect students' attention and learning, and to monitor and adapt their instructional language accordingly. As instructional language is not characterized by just pace and redundancy, but also by syntax, discourse structure, reference, topic management, choice of lexicon, and so on, teachers would do well to consider also these other aspects of their instructional language, observe their effects, and modify their 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." How teachers choose to modify their instructional language depends on both the expected implications for individual students, and the teacher's educational beliefs and goals. For example, a teacher would adjust his or her instructional language differently depending on: whether that teacher viewed maximizing students' attention or learning as more important, whether the teacher believed that it was more important for all students to achieve similarly or for each student to reach his or her different potentials, whether the teacher interpreted the differences of special needs students as deficits, and the teacher's philosophy about how remediation of deficits ought to be handled. This suggests that it is imperative for instructors to know their students (which implies thorough and ongoing assessment), to attend closely to feedback, to know their own goals, and to make thoughtful, informed decisions about the way they use instructional language.

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, teachers could either talk fast when addressing the whole class, 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 teachers want to promote the kind of learning measured by the picture task, their rule of thumb should be to 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 verbal recall, they should talk fast and nonredundantly to special needs students, and slowly and redundantly to regular students. As there was variation among students, these general heuristics would have to be further modified for individual students. (This, of course, would be impractical for whole-class instruction of heterogeneous classes, and thus implies the necessity of grouping students and/or 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 when teaching new and challenging material.

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 would not learn to use learning strategies necessary for slower-paced tasks (like reading, for example).

These findings also remind us that teachers and students often might have different goals. While a teacher's goals for an expository lesson might include promoting students' attention and learning, any particular student's goal might be to allocate "just enough" attention to the school task while still being free to attend to other thoughts and events.

Finally, by examining only the teacher's language and the students' recall in the highly structured framework of an expository lesson and minimizing contextual variation, this study has examined only a simplified aspect of classroom communication -- teachers talking and students listening. It also matters how (and when, where, why, and about what) students talk, to the teacher and to each other. It matters how teachers listen, and how students listen to each other. Discourse in the classroom involves many voices contributing many meanings to create a complex structure over time. Classroom talk must be seen within the framework of the classroom activities, relationships, ethos, and goals that make up the classroom culture. This study has examined one type of classroom communication and contributes insight about a small piece of a much more complex whole.

Table 1

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

Grade	Boys	Girls	Total n
		School 1	
1	1	1	2
2	7	8	15
3	3	4	7
Total	11 (8-2)	13 (8-2)	24 (8-2)
		School 2	
1	2	2	4
2	10	16	26
3	-	-	-
Total	12 (7-8)	18 (7-10)	30 (7-9)
		School 3	
1	-	-	-
2	8	10	18
3	-	-	-
Total	8 (8-0)	10 (8-0)	18 (8-0)
		School 4	
1	1	-	1
2	15	8	23
3	-	-	-
Total	16 (7-10)	8 (8-2)	24 (7-11)
		School 5	
1	-	4	4
2	7	13	20
3	-	-	-
Total	7 (8-1)	17 (7-9)	24 (7-10)

Note. Mean age is in brackets.

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 Verbal Recall, 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.

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] $n = 24$.

Table 4
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.

Table 5
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 6
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.

Table 7
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. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

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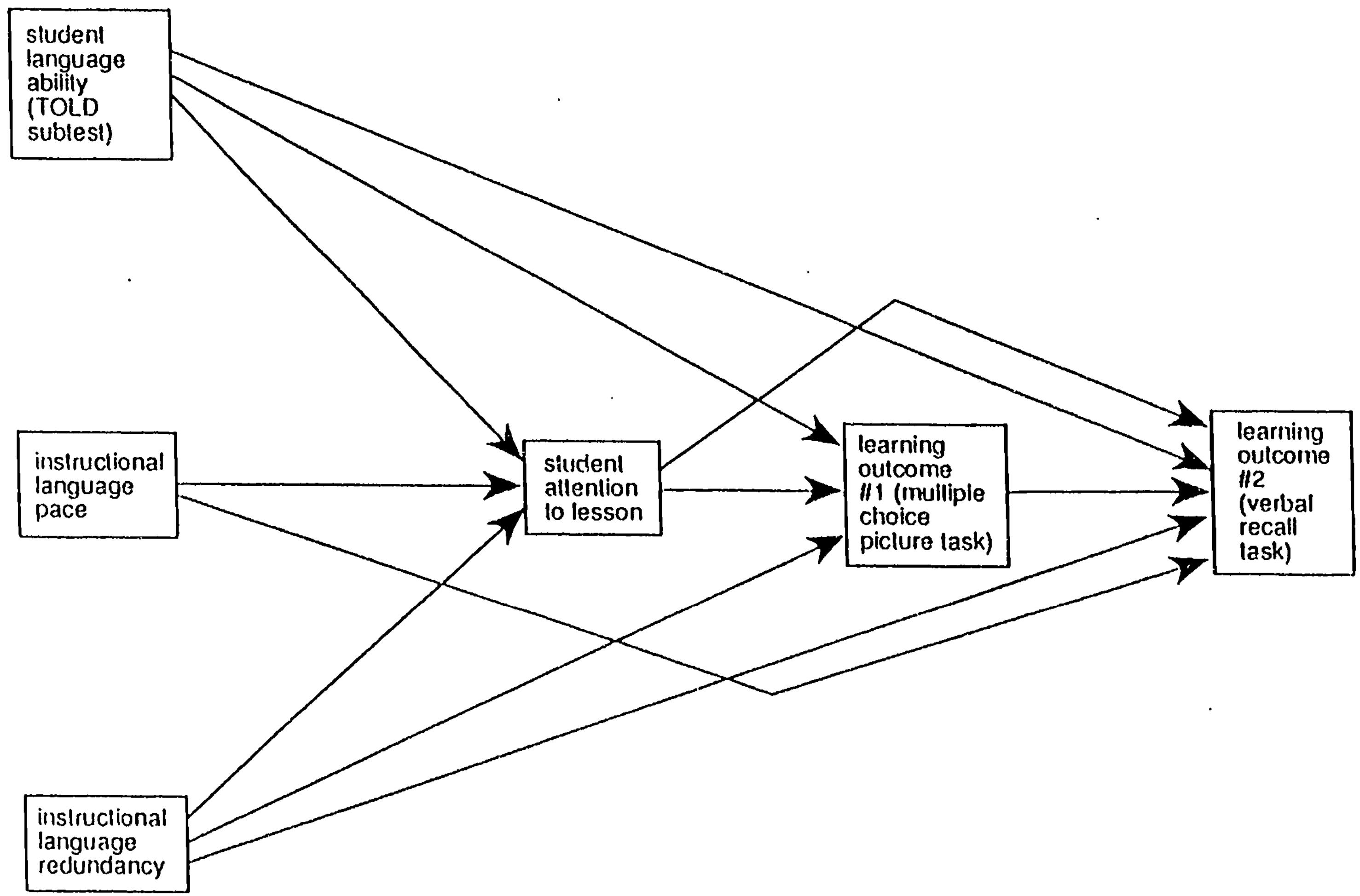
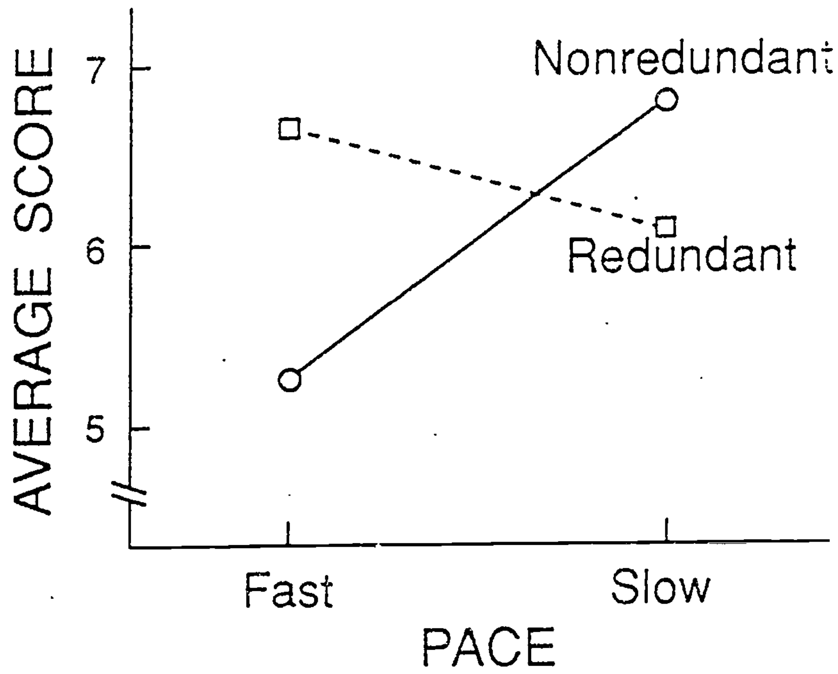


Figure 1. Hypothesized causal model.

PICTURE TASK



VERBAL RECALL TASK:

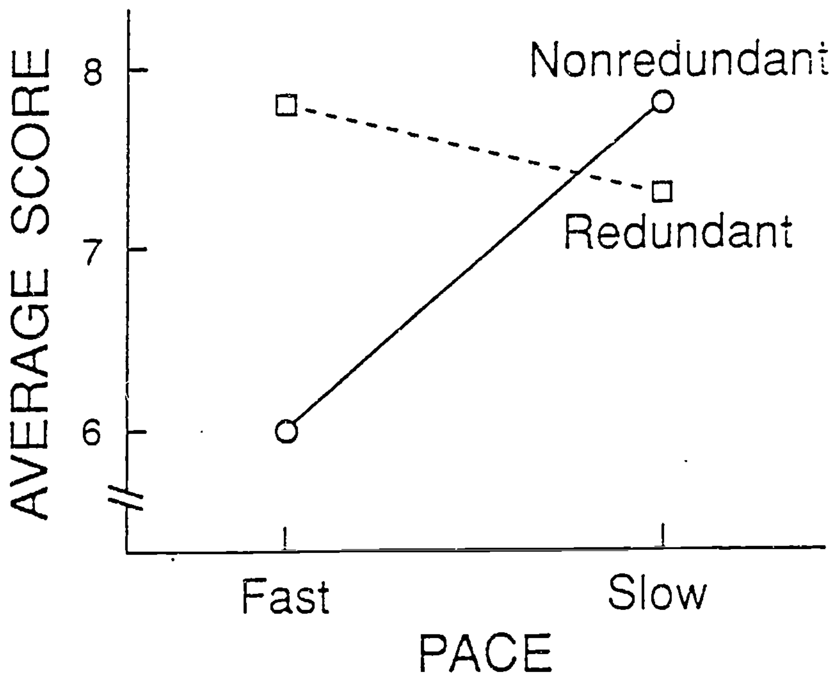
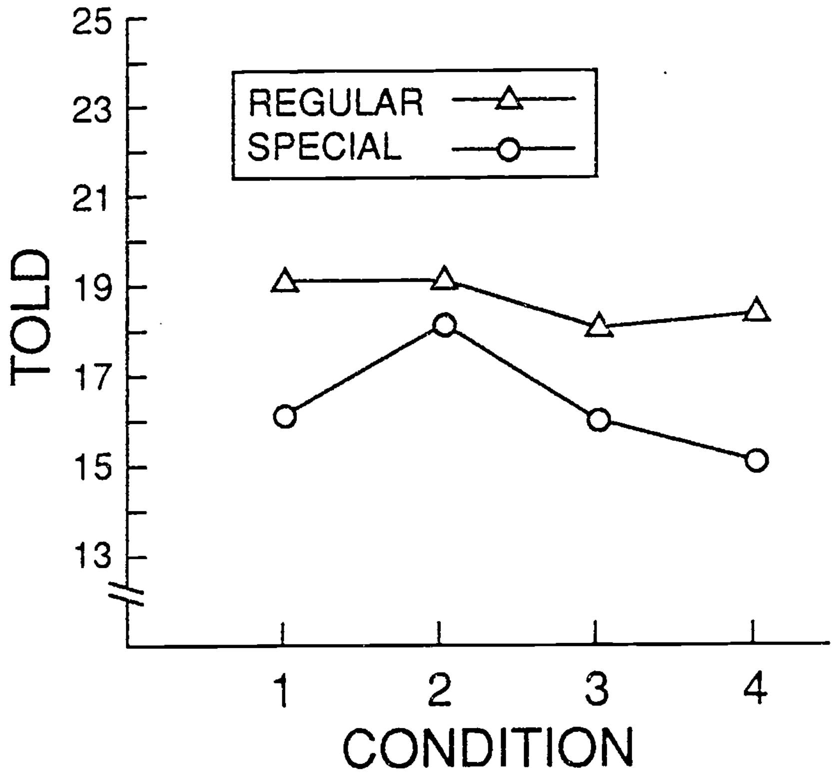
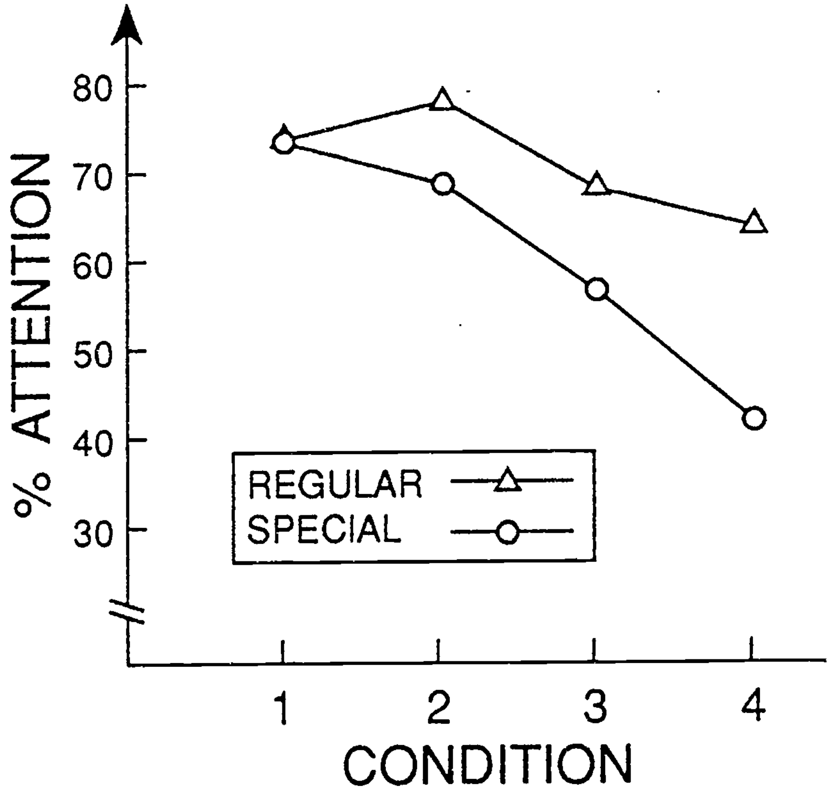


Figure 2. Average scores on the Picture Task and the Verbal Recall Task showing Pace by Redundancy interactions.



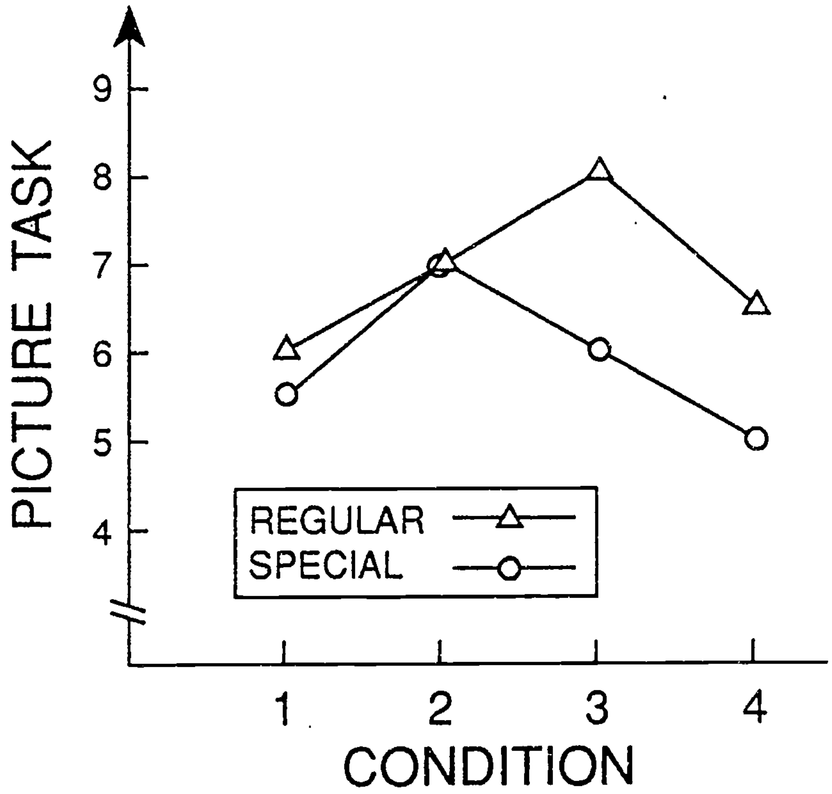
Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 3 . Median *Test of Language Development (TOLD)* subtest scores for regular and special needs students by instructional language condition.



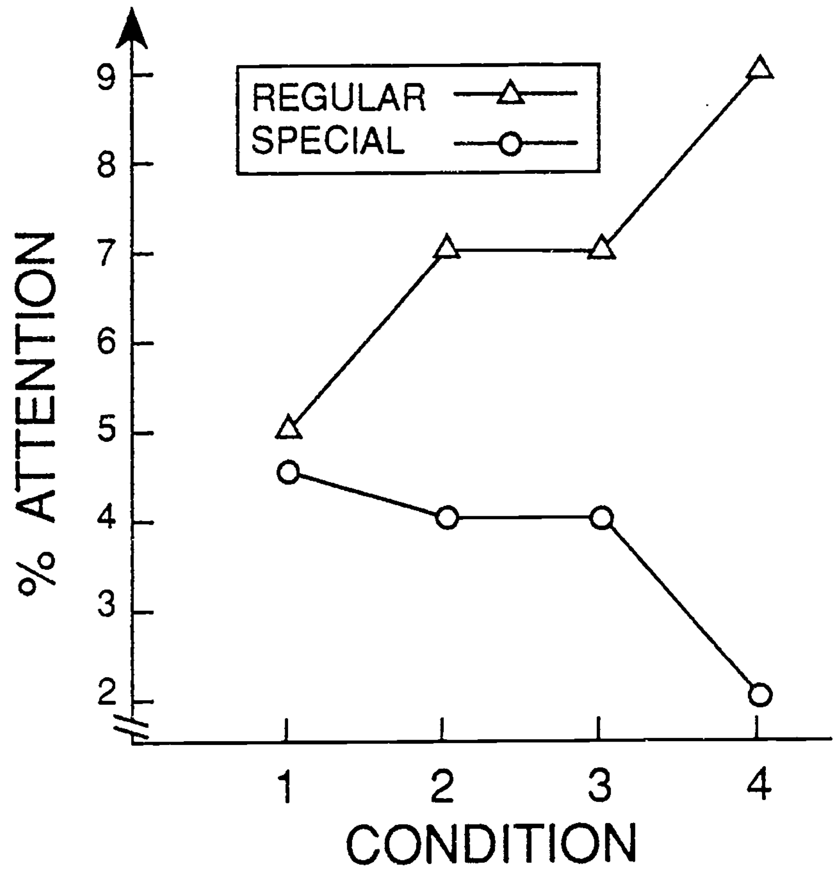
Note: condition 1: fast & nonredundant
condition 2: fast & redundant
condition 3: slow & nonredundant
condition 4: slow & redundant

Figure 4. Median percent attention for regular and special needs students by instructional language condition.



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

Figure 5. Median picture task scores for regular and special needs students by instructional language condition.



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

Figure 6. Median verbal recall scores for regular and special needs students by instructional language condition.

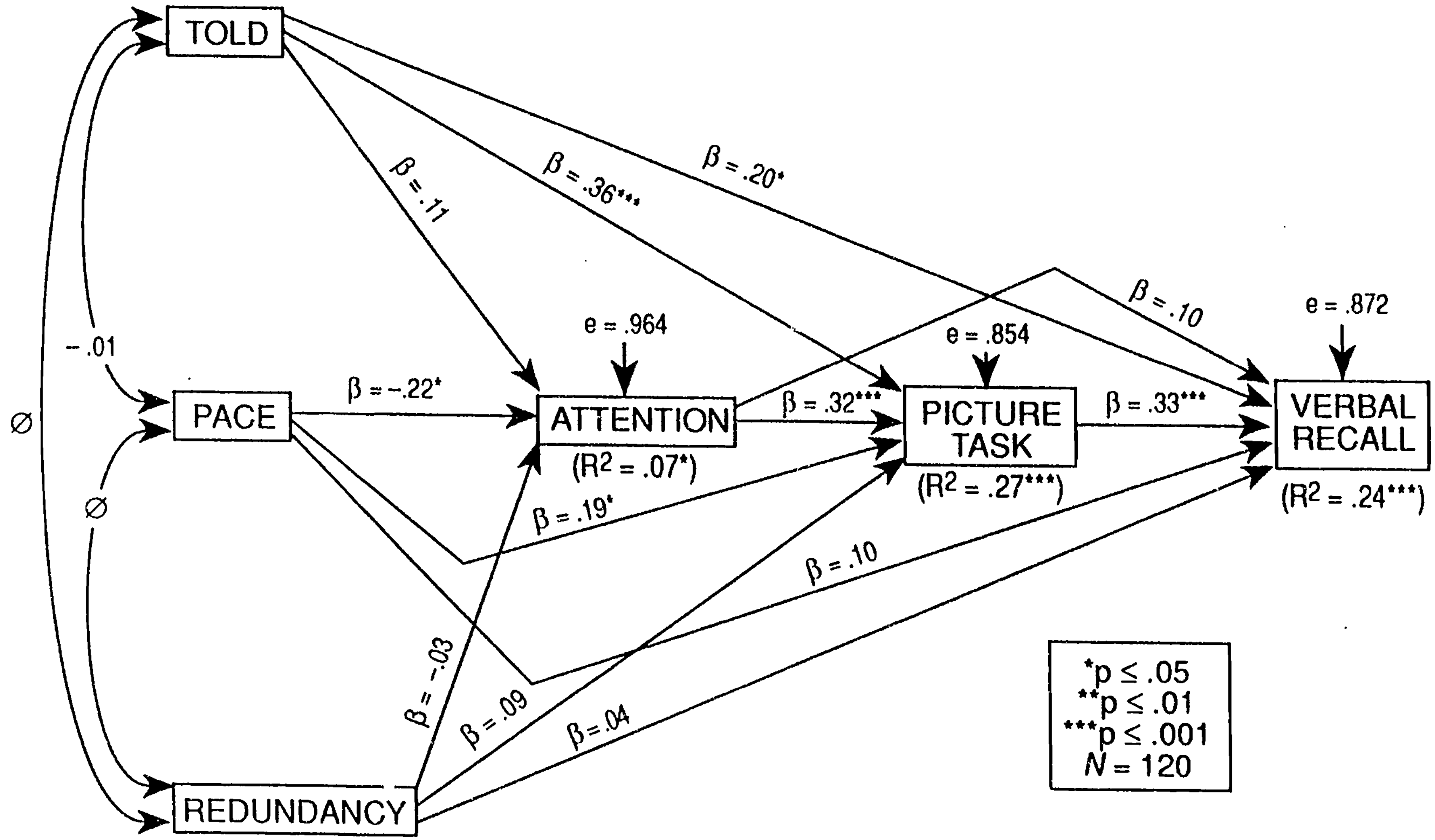
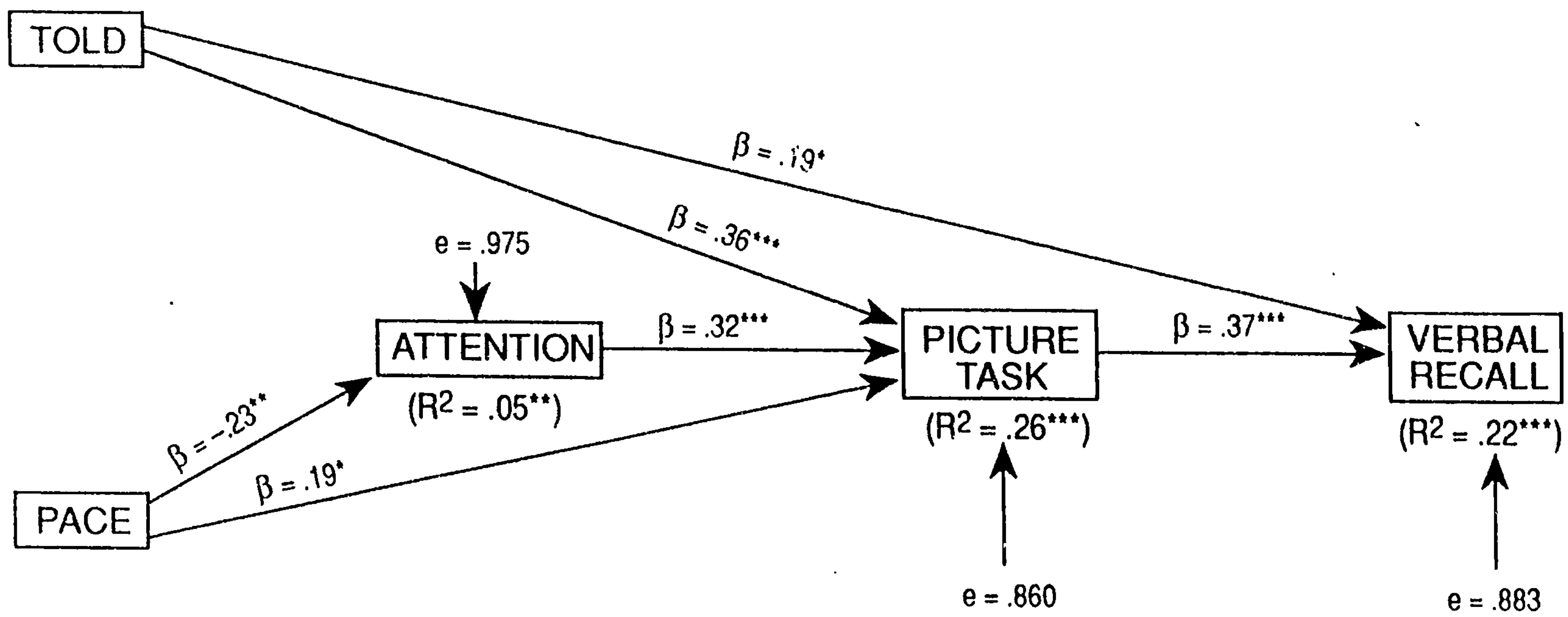


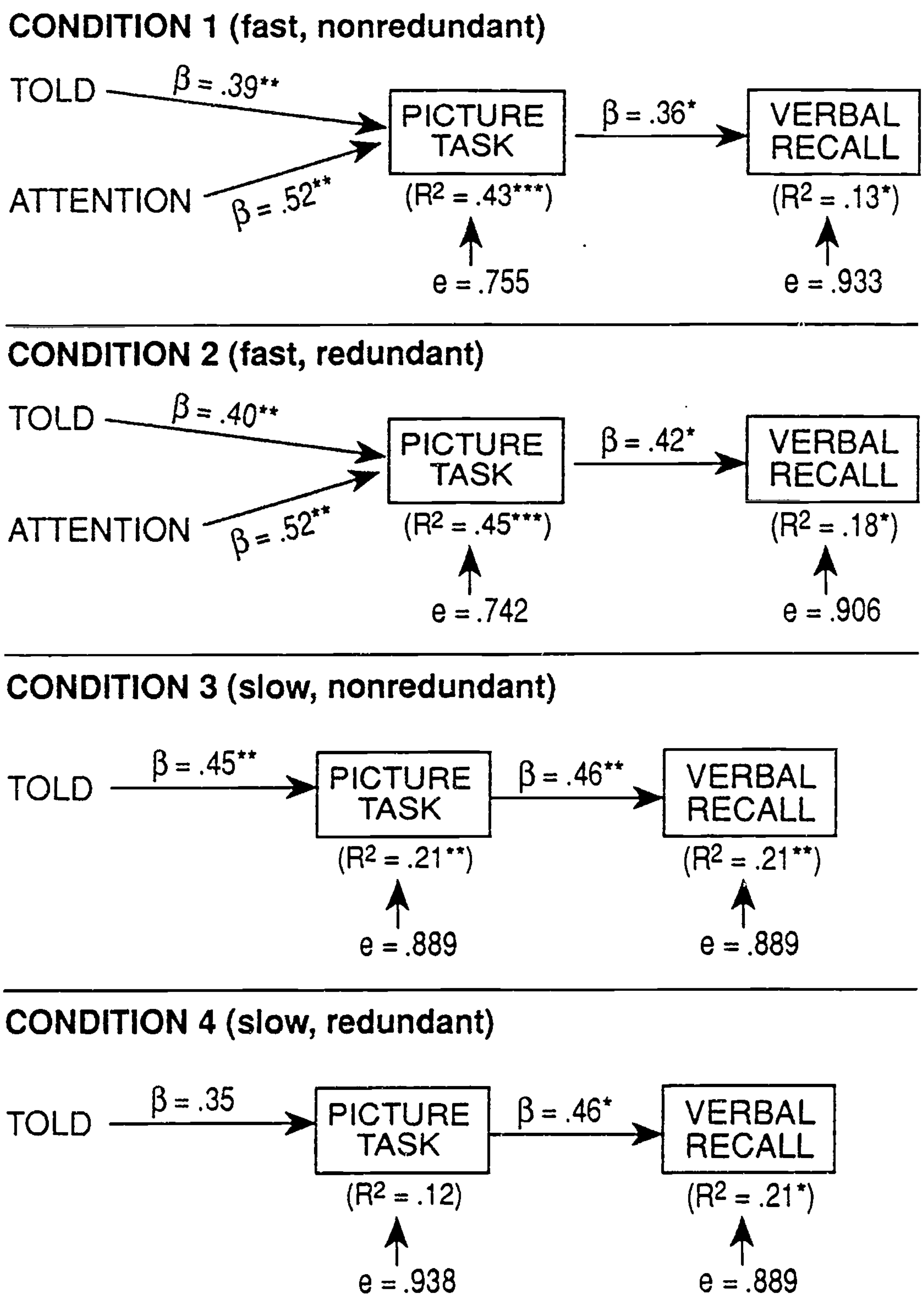
Figure 7. Hypothesized causal model, fully-specified.



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

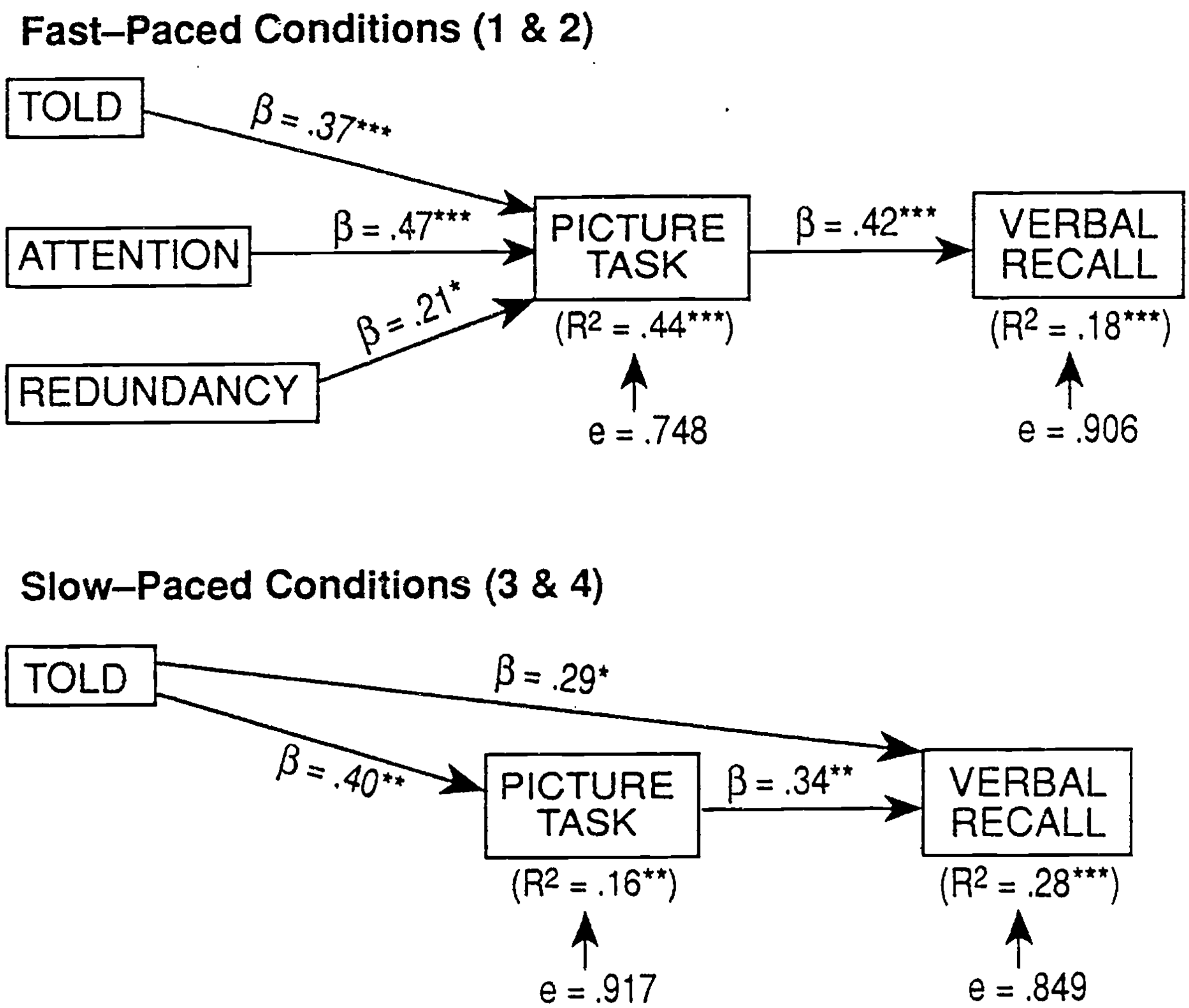
$^{*}p \leq .05$
$^{**}p \leq .01$
$^{***}p \leq .001$
$N = 120$

Figure 8. Theory-trimmed causal model.



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

Figure 9 . Separate causal models for instructional language conditions.



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

Figure 10 . Separate causal models for fast-paced and slow-paced instructional language conditions.

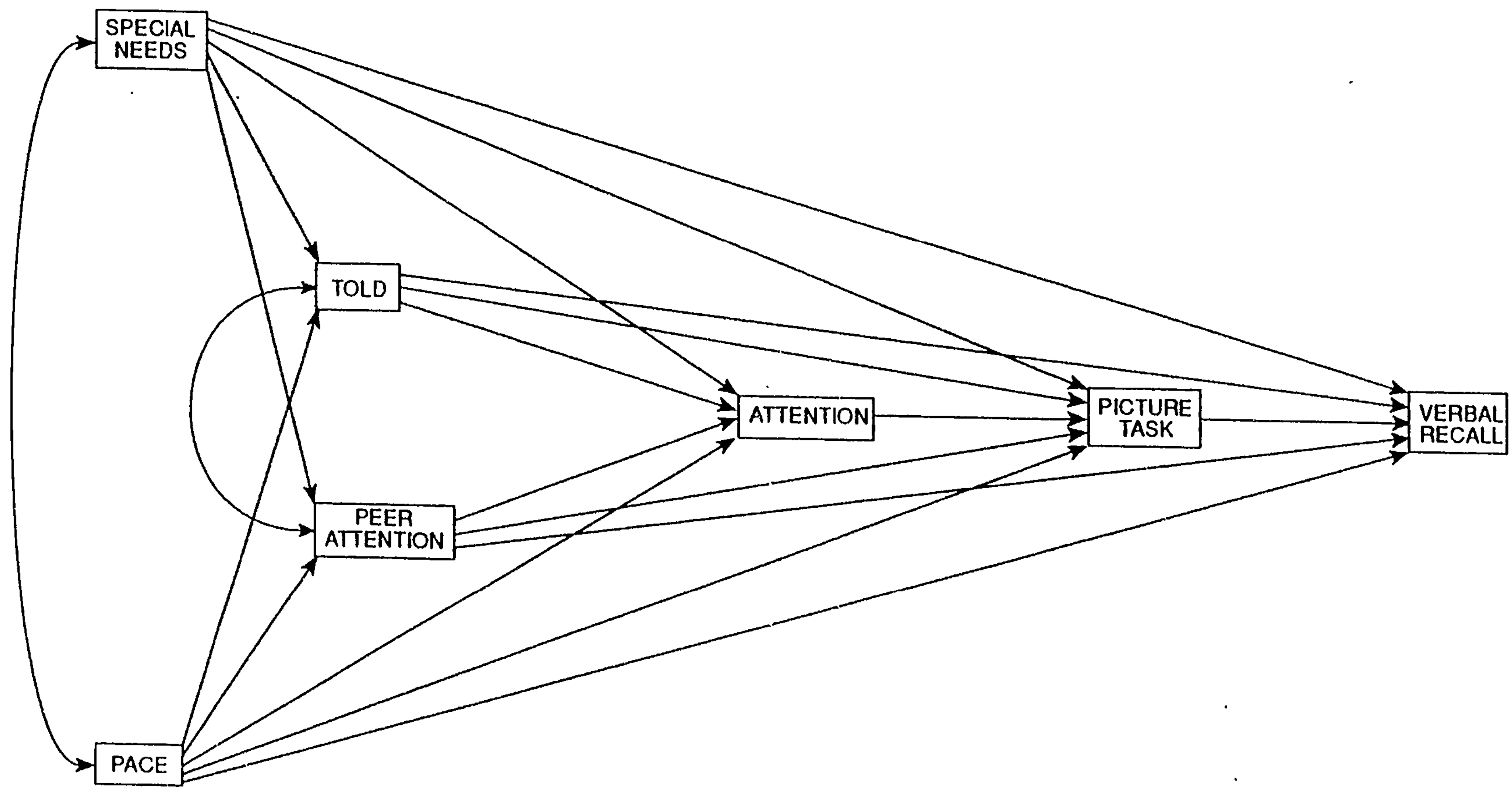
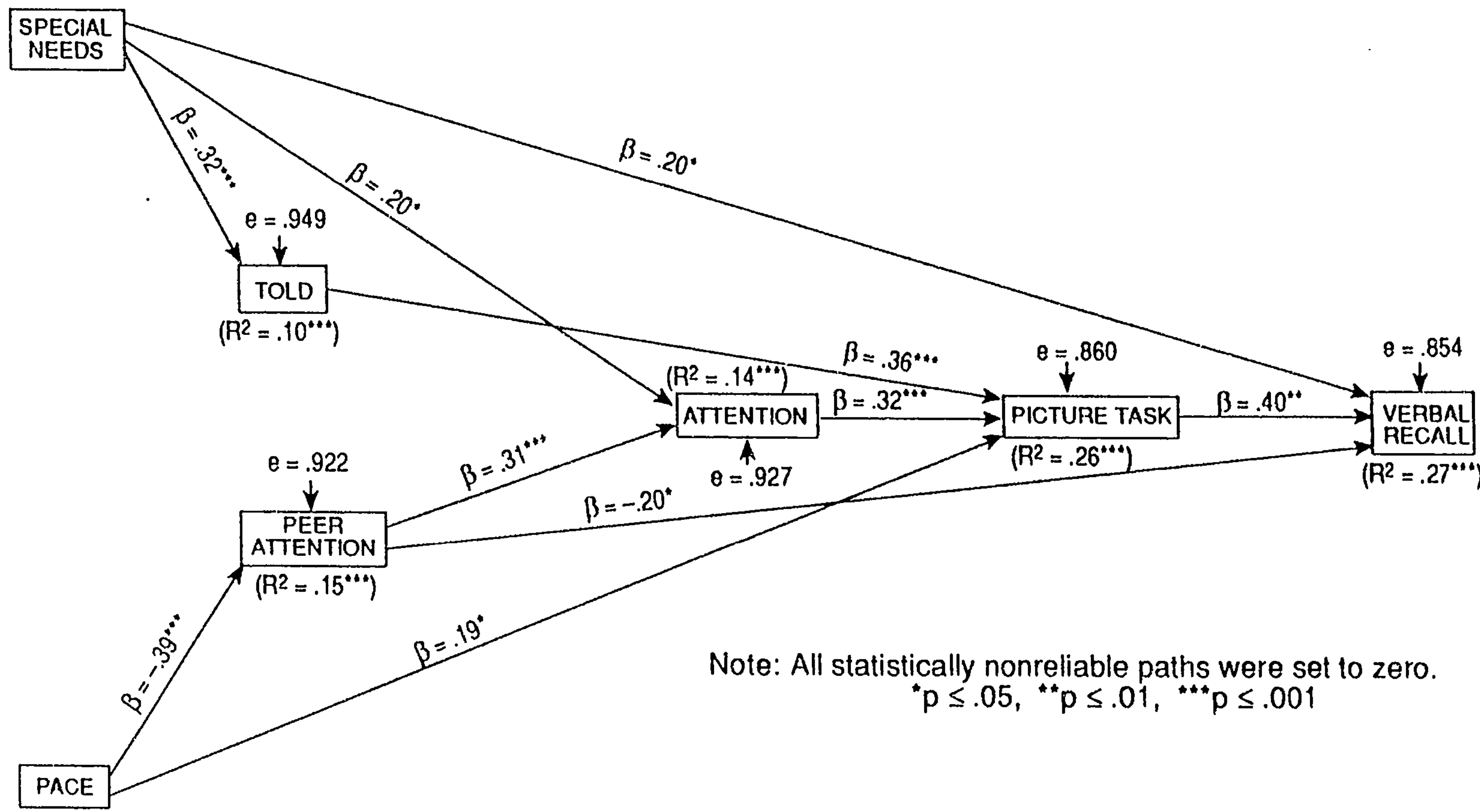


Figure 11. Alternative causal model including special needs and peer attention.



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

Figure 12. Theory-trimmed model including special needs and peer attention.