# THE EFFECTS OF HEARSEE/SAY AND HEARSEE/WRITE TRAINING ON ACQUISITION, GENERALIZATION AND RETENTION

Laraine Theresa Zanatta, B.A.

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APPROVED:
Jesús Rosales-Ruiz, Major Professor
Shala Ali-Rosales, Committee Member
Sigrid Glen, Committee Member
David Hartman, Dean of the School of Community Service
C. Neal Tate, Dean of the Robert B. Tolouse School of Graduate Studies

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This study examines the effects of training in two yoked learning channels (hearsee/say and hearsee/write) on the acquisition, generalization and retention of learning. Four fifth-grade participants were taught the lower-case letters of the Greek alphabet. Twelve letters were taught in the hearsee/say channel and twelve letters were taught in the hearsee/write channel for equal amounts of time. The see/say channel reached higher frequencies at the end of training and showed higher acquisition celerations than the see/write channel. However, the see/write channel showed higher accuracy and retention than the see/say channel. The see/write channel also showed greater generalization across learning channels including the see/say, think/say, think/write and see-name/draw-symbol.

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# CHAPTER 1

## INTRODUCTION

One contribution of Precision Teaching to education is the notion of learning channels. A learning channel is a combination of one or more sensory inputs with one or more responses described in terms of action verbs (e.g. hear, see, think, say, write). Thus, we can have a see/say channel that is different from a see/write channel that is different from a see/match channel. All three may involve the same sensory input but the response makes each combination a different behavior (Haughton, 1980; Lindsley, 1994, 1998). They are considered different behaviors not only because they represent different topographies but also because they are affected differently by other variables (e.g., a student may learn the same material faster with the see/say channel than with the see/write channel).

Learning channels have typically been fully described using two phrases. Each phrase is comprised of three parts: an action verb, an adjective, and an object (e.g., See capital letter D, then say its name). Lindsley (1994) suggested that this description is limiting since it does not include the learners' presentation of the next stimulus. Does the learner point to the letter on a sheet or does the learner flip cards in order to see the next letter? He recommended that a complete learning channel be described using four phrases instead of two (e.g., See the practice sheet, point to the next letter, see the letter D, and say its name). This more complete description now includes the behavior (point) that

exerts control over the level of fluency a learner may reach. That is, a learner can only say letter sounds as fast as he or she can point or flip to the next stimulus presentation. If it is necessary to abbreviate using two verbs, he suggests instead of describing the behavior as see/say, describing it as point/say hence including the crucial behavior.

The notion of learning channels resulted from the lack of clear descriptive language in the field of education. Specify learning channels helps clarify the way information is presented and in what way a person responds. Traditional educational statements like "knows," "recognizes," "is able" and "understands" are changed to more clear-cut actions describing the environmental inputs and responses (Haughton, 1980). For example, a more specific way to describe that Anthony "knows" his letter sounds is to state what he actually does and the conditions under which he does it: Anthony can hear letter-name/say it's sound, hear letter-sound/write the letter, see letter/say it's sound, etc.

Prior to 1980, Precision Teachers used lists of channel components (i.e., see, hear, say, point, etc.) to help describe learning outcomes. These lists were found to be random, unsystematic and limiting in the number of combinations they produced. In response, Haughton (1980) developed 3 matrices (The Academic-Personal-Social Matrix, The Activity Matrix, and The Mobility Matrix) to display many of the possible channel combinations. He ordered the inputs from bottom to top on the left side of the matrix, while listing the outputs across the bottom. The intersections formed by rows and columns are called channel sets. Figure 1 shows Haughton's Academic-Personal-Social Development Matrix. This matrix captures behaviors typically seen in educational

settings as well as in personal and social environments. When used by educators, the matrix can facilitate the writing of concise learning objectives by filling in as many intersecting boxes as possible. The end result is a collection of numerous ways one may choose to teach a specific objective. Also, by looking at a partially filled matrix, new ways to combine learning channels may become more apparent. This is an important point to consider because using multiple channels with the same target behavior has been said to add variety to instruction and practice and may also promote generalization (cf. Stokes and Baer, 1977).

Although the matrix has been very helpful in organizing learning channels, it is only capable of displaying 2-dimensional descriptions. That is, it cannot easily be used to yoke different channel components. Yoking refers to combining two or more components at either side of the learning channel. For example, hearsee/say indicates hearing and seeing a stimulus then saying the response. See/saywrite involves seeing a stimulus then saying its name and writing it down (Lindsley, 1998).

In addition to the benefits of clear description and lesson planning derived from the use of learning channels, they have also been used to choose teaching formats. Lindsley (1998) noted that the channel a learner performs best in (the highest frequency) is not always the channel that the student learns best in (the steepest celeration). Precision Teachers often try to identify a learning channel that produced the best learning in particular students and exclusively teach in that channel while remediating the channels that are weaker. Similarly, Lindsley (1998) suggested that the hear/say learning channel is the best entry channel when starting a new curriculum. However more research

is needed to determine the best entry and teaching channels for different curricula and children.

Arnesman (1982) investigated the relative independence of four learning channels: hear/write, see/write, see/say and touch/say. He hypothesized that learning in one channel would be independent of learning in the three other channels. Five developmentally delayed adults living in a community-based program were the participants in this study. A specific goal from each participant's Individual Program Plan was chosen and adapted to each of the four learning channels. Daily one-minute timings were taken every day in each of the four learning channels. An analysis of the median beginning and ending frequencies shows that the see/write and see/say channels produced slightly better accuracy than the other two channels. Differences in the median ending frequency levels were also noted among the four channels. The see/say yielded a frequency of 32 correct responses per minute, the see/write yielded a frequency of 33, the hear/write yielded a frequency of 12 and the touch/say yielded a frequency of 3 per minute. Looking at median celerations of the four channels, the maximum celeration of correct responses was X1.1 with errors decelerating at /1.1 per week for the see/say channel. The hear/write and touch/say channels yield a median celeration of correct responses X1.1 and no change was seen in incorrect responding. The see/write channel showed no change in either correct or incorrect responses. Thus, for these students the see/say channel produced the best performance and learning.

Thompson (1985) compared four learning channels: see/write, hear/write, see/say and hear/say across three reading levels with six learning disabled and two emotionally

disturbed middle school children. At approximately three-week intervals, the students reading materials were changed from Reading Level 3 to Reading Level 7 to Reading Level 17+. Reading material at Level 3 was chosen by the student, at Level 7 by the teacher from This is America's Story (Wilder, Ludlum, Brown, 1966) and at Level 17+ by the teacher from The New World Life Series (Morris, 1963). Daily one-minute timings were completed in each of the four learning channels for each of the three reading levels. Errors were corrected following each one-minute timing.

An analysis of the acquisition data indicated that no significant systematic differences in celerations for correct responses took place across learning channels or across reading levels for all participants. In examining the median ending frequencies of correct responses, Reading Level 17+ yielded the highest frequencies across all learning channels. The median correct responses per minute was 165 for the see/say channel; 39 for the hear/say channel; 28 for the hear/write channel; and 18 for the see/write channel. The median ending frequencies for incorrect responses showed that the see/say channel had a median of five errors while the median in the other three channels was zero.

To date, research and practice has concentrated on the independence of learning channels in terms of learning and performance. An additional way to approach the independence of learning channels is to ask what learning channels produce the most generalization and retention.

With respect to retention of information learned in different learning channels, only one study was found that investigated this topic. Young et al. (1985) looked at the acquisition and maintenance of reading skills by intellectually handicapped deaf students.

Two participants ages 15 and 16 were non-verbal and communicated via sign language. One was developmentally delayed and the other emotionally disturbed. Two lists were constructed with five words or phrases unfamiliar to the participants. These lists were taught with the see/sign and see/match learning channels. During the see/sign task a card with one of the terms written on it was presented to the participant and he/she was to sign the word. During the see/match task the teacher presented a picture card to the participant and asked them to place it under the appropriate word card. The results indicated that the direct instruction procedures were effective in teaching the see/sign and see/match tasks. Celerations were found to be at or above X1.3 per week. The frequencies for both participants were higher in the see/sign task. The frequencies of the see/sign task were maintained after a four-month period without training. However, the see/match frequencies did not maintain. These results are significant because the classroom teacher reported that the participants had never before maintained reading skills after training had ceased.

Although only one formal study looking at the effects of generalization in learning channels was found, there have been many informal reports of generalization occurring in certain learning channels. For example, Lindsley (1994) reported that the Morningside model uses fluency rates in the see/say learning channel to produce generative responding in the see/write channel. Others however, have reported that learning did not generalize across learning channels. For instance, McDade (1997) tells an anecdote where she taught her son to spell words at home using the hear/say channel but when presented with a hear/write test at school, he failed.

Shrivastava (2000) investigated the effects of fluency building on generalization from three phoneme non-words to new combinations of three phoneme non-words and of non-words containing three phonemes to non-words containing five phonemes. She also investigated the generalization from the see/say channel to the hear/say channel and from the see/say channel to the hear/write channel. Timed drills and non-timed practice were compared using two sets of six phoneme cards and two sets of eight non-word cards. Shrivastava found that timed practice produced higher frequencies than the equivalent practice condition. Minimal generalization effects slightly favoring the timed drills were found when going from the non-words containing three phonemes to new combinations of those phonemes. No generalization was found when increasing from non-words containing three phonemes to non-words containing five phonemes. Little generalization was found in testing from the see/say channel to the hear/say channel. Even less generalization was found in testing from the see/say channel to the hear/write channel.

The limited amount of previous research has generally found that learning and performance in one channel is independent of learning and performance in another channel; and that channel effectiveness may vary across learners. There is also some evidence that channels may differently generalize to other channels and that not all channels produce the same retention.

The present study seeks to analyze the learning, performance, generalization and retention obtained from two yoked channels, hearsee/say and hearsee/write in teaching the Greek alphabet to typical fifth graders.

# CHAPTER 2

# METHOD

## Participants and Setting

The participants were 4 typically developing girls between the ages of 10 and 11 years. They attended fifth-grade in a private parochial school located in Denton, Texas. At the request of the experimenter, the principal selected participants from a broad range of academic performance levels. One participant was considered an A student (JB), two B students (CC & KS) and the fourth a C student (SD). The parents signed consent forms and the participants signed assent forms agreeing to their participation (see Appendix A).

The study took place in a conference room adjacent to the fifth-grade classroom. The room had two rectangular folding tables placed side by side with 10 chairs around the perimeter of the tables. The experimenter sat at the corner of the table and the participant sat to her right.

## Materials

The stimuli consisted of the 24 lowercase letters from the Greek alphabet and their printed names. The alphabet was divided into two sets of 12 letters. Each set contained names of similar lengths (between 2-7 letters) and each set contained about the same number of total letters: Set A=50 and Set B=52 letters (see Figure 2).

The Greek letters and their printed names were presented in several formats. Each of the 24 Greek lowercase letters was printed in random order down the left column on a sheet of paper. The right column contained a line for the participant's response. The sheet was set vertically and contained a place to mark the type of test (Pre, Post, or Retention). There were also lines for the participant's name and date at the top of the page. A line at the bottom of the sheet was left for the experimenter to record the duration of the task (see Appendix B). The names of the Greek letters were also presented in this format. All 24 names of the Greek letters were listed down the left column while the right column contained a line for the participant to draw the corresponding symbol (see Appendix B). A blank version of this sheet was also used. During one test, the experimenter recorded the participant's verbal responses in the right column. In another test, the participants wrote their own responses in the right column. The left column was used for scoring purposes on both sheets (see Appendix B).

Another format utilized 2 1/2 x 4 inch cards printed on medium weight cardstock. Each letter was printed in black ink and centered on the front of the card. The letter name, printed in light gray ink, was centered on the back of the card (see Appendix C).

The letters from Set 2 were also printed on an 8 1/2 x 11 inch piece of paper set horizontally. This sheet had two lines in the top right corner for the participant's name and date. Divided into three columns, each contained 15 letters printed in random order with a line next to each letter for the participant's written response (see Appendix C).

A data sheet was designed to keep track of the participant's scores during the ten timings completed each session. This sheet was comprised of eleven narrow columns.

The first column listed the dates of each session. The next 10 columns were grouped into two sets of five columns each. The first five columns displayed the data gathered from the hearsee/say timings and last five columns displayed the data gathered from the hearsee/write timings. Both sets of five columns were labeled with the duration of each timing: 1m, 15s, 15s, 15s and 1m. (See Appendix C)

Other materials used included a timer, a counter, three sharpened #2 pencils, timings charts and the daily standard celeration chart.

Measurement

Dependent Variables. The dependent variables of this study were the frequency and celeration of correct responses, incorrect responses and passes per week. Responses were saying and/or writing the name of each letter, and drawing the letter. A saying response was counted as correct when the participant pronounced all the syllables of the letter name correctly, as incorrect when the participant mispronounced the letter name or said the wrong letter name and as a pass when the participant said "pass" on any stimulus presentation. A writing response was counted as correct when the participant wrote all the letters comprising the correct letter name, as incorrect when the participant wrote the wrong letter name or wrote the right letter name but spelled it incorrectly and as a pass when the participant drew a line or left the line blank. A drawing response was counted as correct when the participant drew the corresponding symbol for the letter name listed, as incorrect when the participant drew the wrong symbol or did not draw the symbol with the appropriate features and as a pass when they drew a line or left he line blank. For the purpose of data analysis all passes were counted and charted as incorrect responses.

Timing Procedures. Two timing procedures were used to calculate the speed of responding, a fixed time and a total duration time. The fixed timing lasted for 15s or 1 minute. The total duration timing lasted for the amount of time required to complete the task.

Independent Variables. The independent variables in this study were two instructional formats that involved the yoking of different learning channels: hearsee/say and hearsee/write. Hearsee/say consisted of the participant seeing the stimulus on a card, hearing the name of the stimulus and then saying the name of the stimulus. Hearsee/write consisted of the participant seeing the stimulus on a sheet, hearing the name and spelling of the stimulus and then writing the name of the stimulus on the line next to it.

## Design

To compare the relative effectiveness of different learning channels a single-subject, multiple-treatment design was used (Kazdin, 1982). Each participant experienced both instructional formats. Twelve of the Greek letters were taught using the hearsee/say channel and the remaining 12 were taught using the hearsee/write channel.

## Procedures

The participants were seen individually Monday through Friday starting at 12:30 p.m. Upon arrival, the experimenter went to the fifth-grade classroom and the teacher selected one of the four participants to go to the experimental session. When a participant finished and went back to the classroom, she sent the next participant to the experimental room.

Pre-Test. Before training both the see/say and see/write learning channels were tested. In the see/say test, all 24 cards were shuffled and presented to the participant. The participant was instructed to look at each card and say the name of the letter or to say "pass" if she did not know the name of the letter. In the see/write test, the participant was presented with a sheet containing all 24 letters printed in random order. The participant was instructed to write the name of each letter on the line next to it or to draw a line to indicate a pass on that item if she did not know the name of a letter.

The timer was set to the count-up mode and the participant was asked "Are you ready?" Once the experimenter got confirmation that the participant was ready, she then said, "Please begin" and pressed start on the timer. The experimenter stopped the timer when the participant indicated that she was finished with the task. Upon completion of the Pre-tests, the experimenter said to each participant "Good Job! We will start training next week."

Hearsee/say and Hearsee/write Training. A training session consisted of a one-minute practice timing and three 15s sprint timings for both learning channels. The one-minute practice timing, performed first, was intended to build accuracy. Three 15s sprint timings followed and were intended to build speed. During these timings the experimenter and participant worked together. The timer was set for the desired time (1m or 15s) and the participant was asked "Are you ready?" Once the experimenter got confirmation that the participant was ready, she then said, "Please begin" and pressed start on the timer. When the timer beeped, the experimenter pressed the stop button and

counted the number of correct responses, incorrect responses and passes. All training sessions began with the hearsee/say channel and ended with the hearsee/write channel.

During the hearsee/say training the participant was supplied with a deck containing 12 cards from Set 1. The experimenter demonstrated for the participant how to flip through the cards one at a time and told them the following instructions: “Please continue flipping through the deck until the timer beeps. I will say the name of each card first and you should repeat after me.” As the participants became more fluent in each saying response they would say the names in unison with the experimenter. Corrections in pronunciation were made as needed.

During the hearsee/write training the participant was supplied with a training sheet containing the 12 letters from Set 2. This sheet was used continuously for the one-minute timing, three 15s sprint timings and the one-minute test. Lines were drawn where the participant stopped at the end of each timing. The following session was started where the participant left off from the previous session. The experimenter told the participants the following instructions: “During the one minute timing and three 15s sprint timings I will say and spell the name of each letter and you should write the name on the line.” As the participant became fluent in each writing response, the experimenter no longer spelled the letter names but continued to say them.

Daily 1-minute Test. After training in each channel was completed a 1-minute test was conducted as a learning check. The participant worked independently and the experimenter did not provide corrective feedback.

Cross-Channel Tests. During these two tests the participant was required to say the 12 letter names she had learned to write and write the 12 letter names she had learned to say. For the Cross-Channel Say test, the experimenter told the participant the following instructions: "I am going to give you a new deck of cards that show the 12 Greek letters that you were taught to write. Say each name as you flip through the deck or say pass if do not know the name of the letter. This test will be timed for one minute." For the Cross-Channel Write test, the experimenter told the participant the following instructions: "I am going to give you a new sheet that shows the 12 Greek letters that you were taught to say. Write each name on the line next to it or draw a line if you do not know the name of the letter. This test will be timed for one minute." The experimenter did not provide corrective feedback.

See-name/Draw-symbol Test. During this test the participant was to draw the Greek letter given the name of the letter. Participants were given a sheet that had all the names of the letters typed in a column at the left side of the page. The experimenter told the participant the following instructions "Draw the symbol as best as you can on the line next to each name. When you are finished put you pencil down and I will stop the timer." Corrective feedback was not provided.

Think Tests. There were two think tests: Think/Say and Think/Write. For the Think/Say test, the experimenter told the participant the following instructions: "Please say as many names from the whole Greek alphabet as you can and I will write them down on the think/say sheet. Tell me to stop the timer when you are finished." During the Think/Write test, the participant was supplied with the Think/Write sheet and the

experimenter told the participant the following instructions: “Please write down as many names from the whole Greek alphabet as you can remember. I will stop the timer when you place your pencil down.” Corrective feedback was not provided during these tests.

Post Tests. The post-tests were a repetition of the pre tests in both the see/say and see/write learning channels. They were administered following the completion of training and other tests.

Retention Tests. Approximately one month after the training was completed the experimenter re-administered all the tests in this order: See/Say All, Cross-Channel Say, Cross-Channel Write, Think/Say, and Think/Write, See-name/Draw-letter, and See/Write All.

# CHAPTER 3

# RESULTS

Figure 3 shows the accuracy and speed of responding during the daily 1-minute tests for all participants in the see/say (top graphs) and see/write (bottom graphs) learning channels. Each column shows a participant's performance in both channels. The black dots represent correct responses per minute and the X's represent incorrect responses per minute. X's displayed below the 1 minute floor line indicate that no errors were made during that timing. Acquisition celeration lines are drawn in light gray and their values are displayed to the right. Celeration lines were drawn by visually determining with the help of a straight edge the slope and direction of the trend of the charted frequencies. The slope of the celeration is expressed as a factor (e.g. X1, X10, /15, /30) and quantifies the amount of weekly change in behavior.

JB's correct responding in the see/say learning channel accelerated at X3.5 per week while her incorrect responding decelerated at /100 per week. JB's correct responding in the see/write learning channel accelerated at X50 per week while her incorrect responding decelerated at /10,000 per week. SD's correct responding in the see/say learning channel accelerated at X8 per week while her incorrect responding decelerated at /100 per week. SD's correct responding in the see/write learning channel accelerated at X3 per week while her incorrect responding decreased at /15 per week.

CC's correct responding accelerated at X3.5 per week in the see/say learning channel while her incorrect responding decelerated at /100 per week. CC's correct responding in the see/write learning channel accelerated at X3 per week while her incorrect responding decreased at /10 per week. KS's correct responding in the see/say learning channel accelerated at X5 per week while her incorrect responding decelerated at /60 per week. KS's correct responding in the see/write learning channel accelerated at X3.1 per week while her incorrect responding decreased at /10 per week.

Figure 4 shows a summary of the acquisition celerations during the see/say and see/write learning channels. The results are displayed on a base 10 multiply scale with X1 in the center of the chart. Two cycles of multiply factors go above this line (e.g. X10 & X100) and two cycles of dividing factors go below this line (e.g. /10 & /100). The black dots represent correct responses and the X's represent incorrect responses. The median celeration for correct responses during the see/say learning channel was X4 and /100 for incorrect responses. The median celeration for correct responses during the see/write learning channel was X3 and /12.5 for incorrect responses.

Figure 5 shows the last frequencies from the see/say and see/write daily 1-minute tests. The median frequency of correct responses during the see/say 1-min test was 78 per minute and 0 for incorrect responses. The median frequency of correct responses during the see/write 1-minute test was 26 per minute and 0 for incorrect responses.

Figure 6 shows the frequency jump of correct and incorrect responding from posttest to retention test for the see/say and see/write learning channels. The frequency jump is calculated by dividing the highest frequency by the lowest frequency from the

posttest and the retention test. A multiply sign is used when the retention frequencies are higher than the post test frequencies. A divide sign is used when the retention frequencies are lower than the post test frequencies. The median frequency jump in the see/say learning channel was /1.5 for correct responding and X5 for incorrect responding. The median frequency jump in the see/write learning channel was /1.2 for correct responses and X1.25 for incorrect responses.

Figure 7 shows the frequency jump of correct and incorrect responding during the crossover tests. In the write-to-say crossover test the median frequency jump for correct responses was /1.1 and X1 for incorrect responses. In the say-to-write crossover test the median frequency jump for correct responses was /1.4 and X12 for incorrect responses.

Figure 8 shows the number of names correctly spoken during the Think/Say, Post and Retention tests. The white bars represent responses trained in the hearsee/say channel and the black bars represent responses trained in the hearsee/write channel. There were 12 possible correct responses for each channel. JB said 11 names from the say set and 11 names from the write set during the posttest. Her retention test data show a decrease of five responses from the say set and a decrease of 1 response from the write set. SD said 7 names from the say set and 7 names from the write set during the posttest. Her retention test data show a decrease of 1 response from the say and an increase of 1 response from the write. CC said 9 names from the say set and 7 names from the write set during the posttest. Her retention test data show a decrease of 1 response from the say set and an increase of 1 response from the write set. KS said 8 names from the say set and 11

names from the write set during the posttest. Her retention test data show an increase of 1 response from the say set and maintained at 11 responses in the write set.

Figure 9 shows the number of names correctly written during the Think/Write, Post and Retention tests. The white bars represent responses trained in the hearsee/say channel and the black bars represent responses trained in the hearsee/write channel. There were 12 possible correct responses for each channel. JB wrote 8 names from the say set and 11 names from the write set during the posttest. Her retention test data show an increase of one response from the say set and maintained at 11 responses from the write set. SD wrote 4 names from the say set and 7 names from the write set during the posttest. Her retention test data show an increase of one response from the say set and a decrease of 2 responses from the write set. CC wrote 3 responses from the say set and 5 responses from the write set during the posttest. Her post test data show an increase of one response from the say set and an increase of 4 responses from the write set. KS wrote 3 responses from the say set and 10 responses from the write set during the posttest. Her retention test data show the 3 say responses maintained and a decrease of 2 responses from the write set.

Figure 10 shows the number of symbols correctly drawn during the See-name/Draw-symbol Post and Retention tests. The white bars represent responses trained in the hearsee/say channel and the black bars represent responses trained in the hearsee/write channel. There were 12 possible correct responses for each channel. JB drew 11 symbols from the say set and 11 symbols from the write set during the posttest. Her retention test data show a decrease of 4 responses from the say set and maintained at

11 symbols from the write set. SD drew 4 symbols from the say set and 7 symbols from the write set during the posttest. Her retention test data show a decrease of 2 responses from the say set and 4 responses from the write set. CC drew 7 symbols from the say set and 9 symbols from the write set during the posttest. Her retention test data show an increase of 1 response from the say set and 3 responses from the write set. KS drew 6 symbols from the say set and 9 symbols from the write set during the posttest. Her retention test data show a decrease of 2 responses from the say set and 3 responses from the write set.

# CHAPTER 4

## DISCUSSION

The results show that for three of the four participants the hearsee/say learning channel produced higher acquisition celerations per week than the hearsee/write learning channel. Participant JB however displayed higher acquisition celerations in the hearsee/write channel. All participants reached higher frequencies (fluency) in the hearsee/say channel than the hearsee/write channel. However, participant's errors in the hearsee/say channel took longer to drop out after 100% accuracy had been achieved the first time. In contrast, no errors occurred in the hearsee/write channel after participants reached 100% accuracy the first time.

These results support previous observations that learning (celeration) and performance (fluency) differ for different channels. Also, individual learners may vary in terms of what channels produce the best celerations and frequencies. Current Precision Teaching practices favor learning channels that the student learns best in. This is due to the fact that the Precision Teaching community universally accepts the notion that higher frequencies (fluency) produce better retention, endurance, application and performance standards (REAPS), or better retention, endurance, stability, application and adduction (RESAA) (Binder, 1996, Johnson and Layng, 1996). Following this recommendation, Precision Teachers would have chosen to teach three of the participants from this study in the see/say channel and teach the fourth participant in the see/write channel. However,

the retention and generalization data do not support this decision. The present data suggest that teaching all children in the hearsee/write channel would be more efficient.

The results show that the channel with higher rates of responding did not produce better retention. The hearsee/write channel produced better retention independent of frequency and celeration of responding. These findings were consistent across all retention tests administered. Even though high rates of fluency have been a good predictor of retention (e.g., Johnson and Layng, 1992; Lindlsey, 1998; Binder, 1996) the present study shows that the learning channel may be a better predictor. Perhaps the fluency hypothesis (i.e. higher rates better RESAA or REAPS) only applies to different tasks within the same channel. Young's (1985) study may be cited as evidence supporting the fluency hypothesis. In his study higher frequencies appeared to be correlated with better retention. Unfortunately, it is not clear if his results are due to the fluency effects or the nature of the channel; that is, the see/sign channel could have produced better retention than the see/match channel independently of its celeration and fluency rates. In contrast, this study found better retention to be correlated with the slower channel. This suggests that the nature of the channel is more important to retention than fluency. Further research is needed to explore this issue.

Precision teaching assumes very little generalization from one learning channel to the next. Consequently, they teach material in all the relevant channels at once. For example, letters may be taught simultaneously in the see/say channel, see/write channel, hear/point channel, and the hear/write channel, etc. Furthermore, generalization is supposed to be a product of fluency, not the channel (Johnson & Layng, 1992; Lindsley,

1998; Binder, 1996). However, this study does not support that conclusion. In this study, material trained in the hearsee/write channel generalized much better than material trained in the hearsee/say channel. For example, the amount of crossover from the write-to-say channel showed that both accuracy and frequency of responding was at the same rate as the original hearsee/say channel. The crossover from say-to-write however produced a large increase in errors with a corresponding decrease in correct responses. Letter names trained in the hearsee/write channel occurred more often in the Think/Say test than names actually trained in the hearsee/say channel. During the Think/Write test letter names trained in the hearsee/write channel occurred more often than ones trained in the hearsee/say channel. Also, the participants were able to draw more symbols from the hearsee/write channel than symbols from the hearsee/say channel. Thus, this data shows that different learning channels can produce different amounts of generalization. Schrivastava (2000) found little generalization from the see/say channel to the hear/say channel and even less generalization from the see/say to the hear/write channel. Perhaps, if she had taught in the hear/write channel, she would have produced strong generalized effects to both the see/say and hear/say learning channels. The findings from the present study would suggest that.

In general, training in the hearsee/write learning channel proved to be very powerful for all participants in terms of generalization and retention. Since learning channels may differentially affect the teaching outcomes, it is necessary to further study what relationships lie within and across different learning channels. It may be that by training in a double yoked channel such as hearsee/say write the outcome may be even

more beneficial for the learner. More efficient ways of teaching particular learners could be derived from this research.

**APPENDIX A: Consent Forms**

Dear Parents,

Hi! My name is Laraine Zanatta and I am a graduate student in the Department of Behavior Analysis at the University of North Texas. I have met with Mrs. B and she has agreed to let me conduct my Masters Thesis with four students in the fifth grade.

Your child has been chosen to participate in my study which will evaluate the effectiveness of different learning channels. He/she will also learn the Greek Alphabet in the process! I will be coming to your child's school every day for approximately 3 weeks. Each individual session with your child will last around 10 minutes. The names of the students in this study will be coded; there will be no use of their names. As a participant in this study, your child will at no time be at any physical, emotional or mental risk. The participation of your child is voluntary and they may withdraw from this study at any time.

I would like to ask your permission to use the data gathered from this study in my Masters Thesis. All information will be strictly confidential. The information gathered from this study may present future benefits to other students at your child's school.

Thank you for your time and cooperation. If you have any questions you may contact me at the Department of Behavior Analysis at (940) 565-2274. Please sign and date below to give consent for you child's participation. Return bottom portion of this notice.

**********

I give permission for my child, _____, to participate in this study.

_____ _____

Parent or Guardian's Signature Date

Dear Students,

Hi! My name is Laraine Zanatta and I am a graduate student in the Department of Behavior Analysis at the University of North Texas. I am interested in the different ways children learn new information. Mrs. B has agreed to let me do my study at your school. You have been selected to participate in my study and will be learning the Greek Alphabet. I will be coming to your class every day for around 3 weeks and will see you individually for 10 minutes each session. The data I collect will be used in my Masters Thesis but your name will be coded so no one will know who you are. You will not be in any physical, mental or emotional risk at any time during this study and you may stop at any time. If you have any questions, you may call my advisor, Dr. Rosales at (940) 565-2559.

**********

Please sign and return the bottom portion of this form if you wish to participate in my study.

_____ _____

Name Date

**APPENDIX B: Testing Materials**

Pre Test _____ Post Test _____ Name_____
Retention Test _____ Date_____

## See-Symbol/Write-Name

| | |
|---|---|
| ν | |
| κ | |
| ρ | |
| ε | |
| φ | |
| η | |
| ξ | |
| α | |
| ψ | |
| ι | |
| ο | |
| τ | |
| λ | |
| β | |
| ω | |
| γ | |
| μ | |
| υ | |
| ζ | |
| σ | |
| π | |
| δ | |
| χ | |
| θ | |
| Total Time | |

Think/Say _____ P R Name_____

Think/Write _____ P R Date_____

## Think Test

| | |
|---|---|
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| | |
| | |
| Total Time | |

Post _____ Name_____

**Ret** ____ **Date**_____

## See-Word/Draw-Symbol

| | |
|---|---|
| Gamma | |
| Nu | |
| Zeta | |
| Omikron | |
| Xi | |
| Eta | |
| Lambda | |
| Delta | |
| Upsilon | |
| Pi | |
| Iota | |
| Rho | |
| Alpha | |
| K'hi | |
| Theta | |
| Tau | |
| Kappa | |
| Mu | |
| Epsilon | |
| P'hi | |
| Sigma | |
| Psi | |
| Omega | |
| Beta | |
| Total Time | |

Cross Test: P R

**SEE-SYMBOL/WRITE-WORD**

Name_____

Date _____

| | | |
|---|---|---|
| ξ _____ | γ _____ | ζ _____ |
| υ _____ | τ _____ | θ _____ |
| φ _____ | λ _____ | ξ _____ |
| λ _____ | μ _____ | α _____ |
| τ _____ | ζ _____ | ι _____ |
| γ _____ | α _____ | λ _____ |
| ψ _____ | ξ _____ | τ _____ |
| α _____ | ψ _____ | υ _____ |
| ι _____ | θ _____ | φ _____ |
| μ _____ | ι _____ | γ _____ |
| ζ _____ | υ _____ | μ _____ |
| θ _____ | φ _____ | ψ _____ |
| γ _____ | μ _____ | θ _____ |
| τ _____ | ζ _____ | ι _____ |
| α _____ | λ _____ | ξ _____ |
| (15) | (30) | (45) |

## APPENDIX C: Training Materials

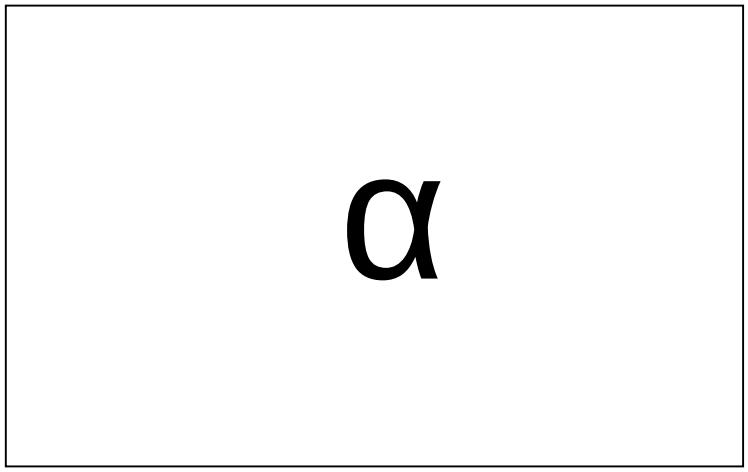
Greek Alphabet- Training Sheet

**HEARSEE SYMBOL/WRITE WORD**

Name _____

| | | |
|---|---|---|
| ν _____ | σ _____ | ε _____ |
| κ _____ | π _____ | β _____ |
| ρ _____ | ο _____ | χ _____ |
| ε _____ | ν _____ | π _____ |
| σ _____ | ε _____ | ν _____ |
| η _____ | ρ _____ | δ _____ |
| π _____ | δ _____ | ρ _____ |
| β _____ | χ _____ | ω _____ |
| χ _____ | η _____ | π _____ |
| ω _____ | ω _____ | κ _____ |
| ο _____ | σ _____ | σ _____ |
| δ _____ | ρ _____ | η _____ |
| κ _____ | κ _____ | β _____ |
| β _____ | ο _____ | δ _____ |
| ω _____ | η _____ | ο _____ |
| (15) | (30) | (45) |

Sample Training Card




# TIMINGS DATA SHEET

SUBJECT:_____

| | SAY | | | | | WRITE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1m | 15s | 15s | 15s | 1m | 1m | 15s | 15s | 15s | 1m |
| | | | | | | | | | | |
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**Figure 1: Eric C. Haughton's Learning Matrix**

INPUT

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Think (T) | | | | | | | | | | | |
| Touch (To) | | | | | | | | | | | |
| Taste (Ta) | | | | | | | | | | | |
| Sniff (Sn) | | | | | | | | | | | |
| See (Se) | | | | | | | | | | | |
| Hear (H) | | | | | | | | | | | |
| Feel (F) | | | | | | | | | | | |
| | Aim (A) | Do (Do) | Draw (D) | Emote (E) | Mark (Mk) | Match (M) | Say (S) | Select (St) | Tap (Tp) | Thought (Tt) | Write (W) |

OUTPUT

**Figure 2: Set 1 and Set 2 Contents**

**Set 1:Hearsee/Say**

| Symbol | Name |
|---|---|
| μ | Mu |
| ξ | Xi |
| ψ | Psi |
| τ | Tau |
| ι | Iota |
| φ | P'hi |
| ζ | Zeta |
| α | Alpha |
| γ | Gamma |
| θ | Theta |
| λ | Lambda |
| υ | Upsilon |

50 letters

**Set 2: Hearsee/Write**

| Symbol | Name |
|---|---|
| ν | Nu |
| π | Pi |
| η | Eta |
| ρ | Rho |
| β | Beta |
| χ | K'hi |
| δ | Delta |
| κ | Kappa |
| ω | Omega |
| σ | Sigma |
| ε | Epsilon |
| ο | Omikron |

52 letters

**Figure 3: Learning Pictures for See/Say and See/Write Learning Channels**

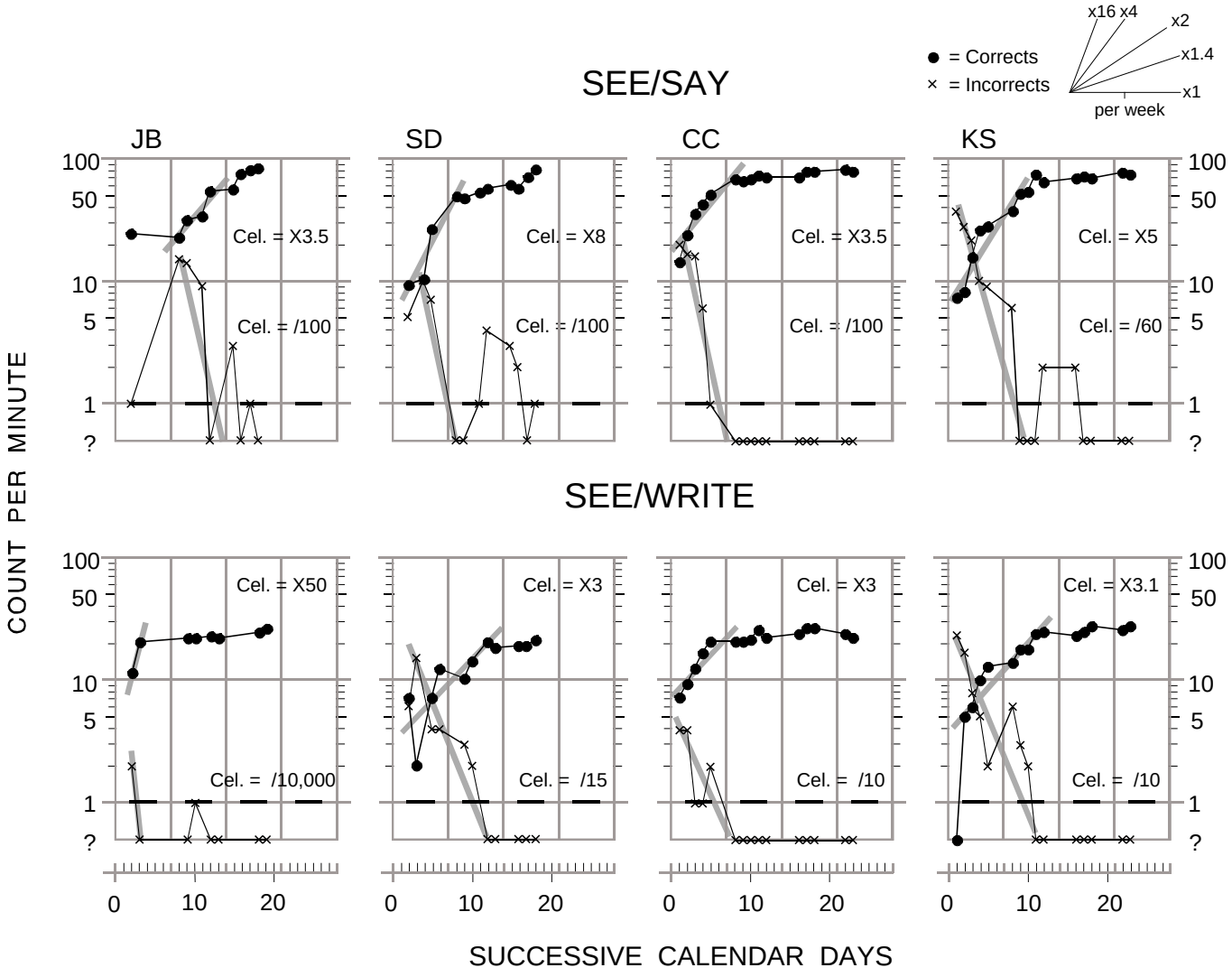

SEE/SAY
JB
SD
CC
KS
● = Corrects
× = Incorrects
x16 x4
x2
x1.4
x1
per week
Cel. = X3.5
Cel. = /100
Cel. = X8
Cel. = /100
Cel. = X3.5
Cel. = /100
Cel. = X5
Cel. = /60
SEE/WRITE
Cel. = X50
Cel. = /10,000
Cel. = X3
Cel. = /15
Cel. = X3
Cel. = /10
Cel. = X3.1
Cel. = /10
100
50
10
5
1
?
0
10
20
COUNT PER MINUTE
SUCCESSIVE CALENDAR DAYS

**Figure 4: Median Acquisition Celerations for the See/Say and See/Write Learning Channels**

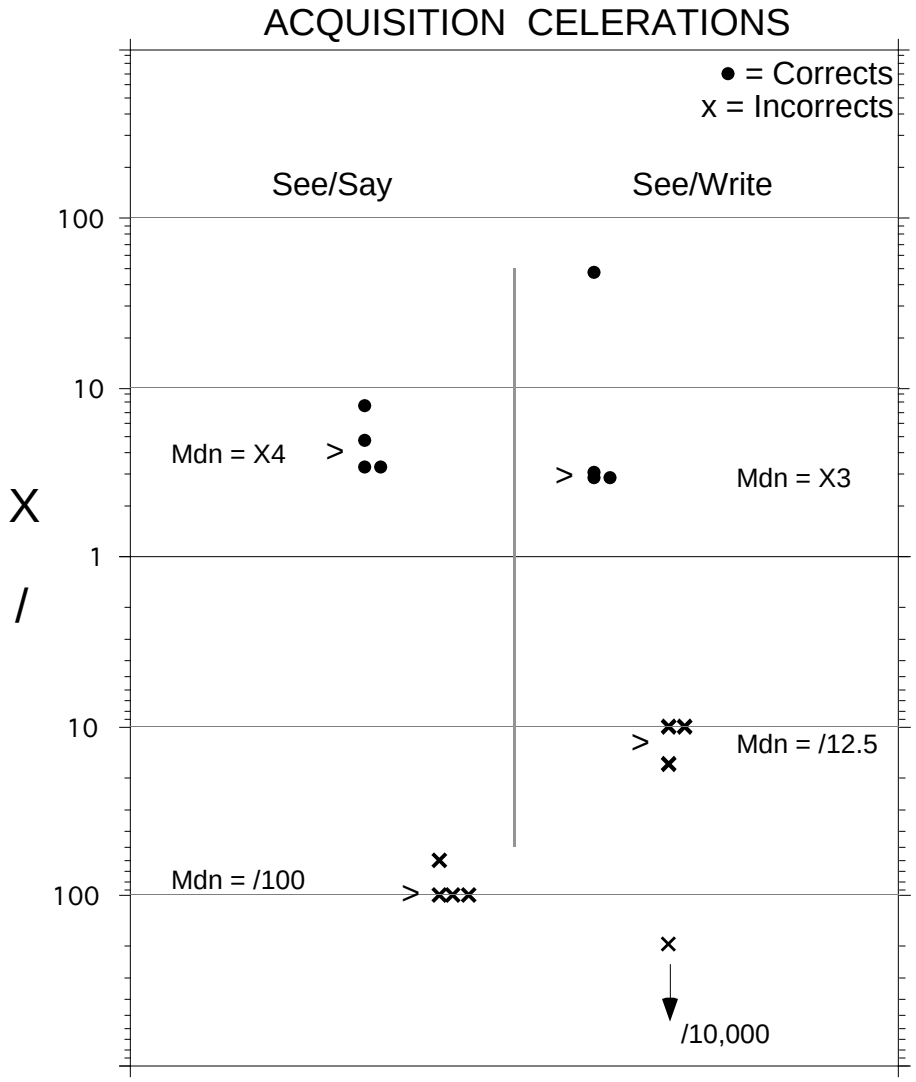

ACQUISITION CELERATIONS
● = Corrects
x = Incorrects
See/Say
See/Write
100
10
1
10
100
X
/
Mdn = X4
>
>
Mdn = X3
>
Mdn = /12.5
Mdn = /100
>
/10,000

**Figure 5: Median Last Frequencies for Correct and Incorrect Responding for See/Say and See/Write Leaning Channels**

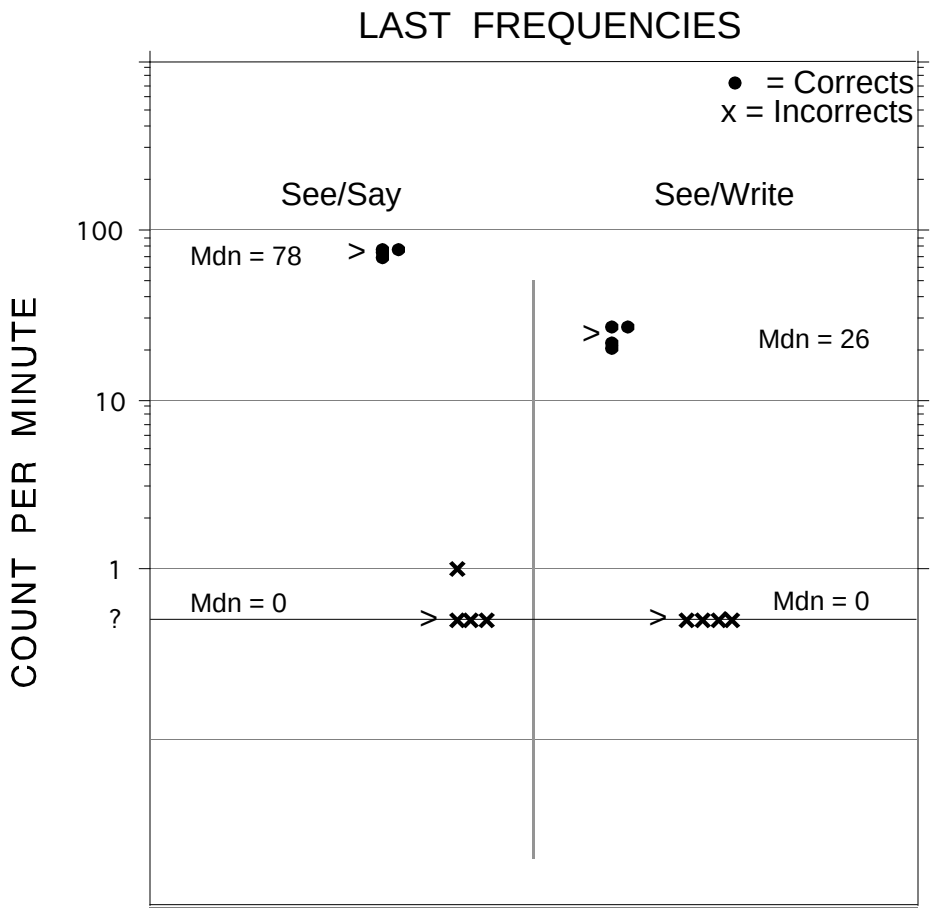

LAST FREQUENCIES
● = Corrects
x = Incorrects
See/Say
See/Write
100
10
1
?
COUNT PER MINUTE
Mdn = 78
Mdn = 26
Mdn = 0
Mdn = 0

**Figure 6: Median Frequency Jumps for Correct and Incorrect Responding for the See/Say and See/Write Retention Test Data**

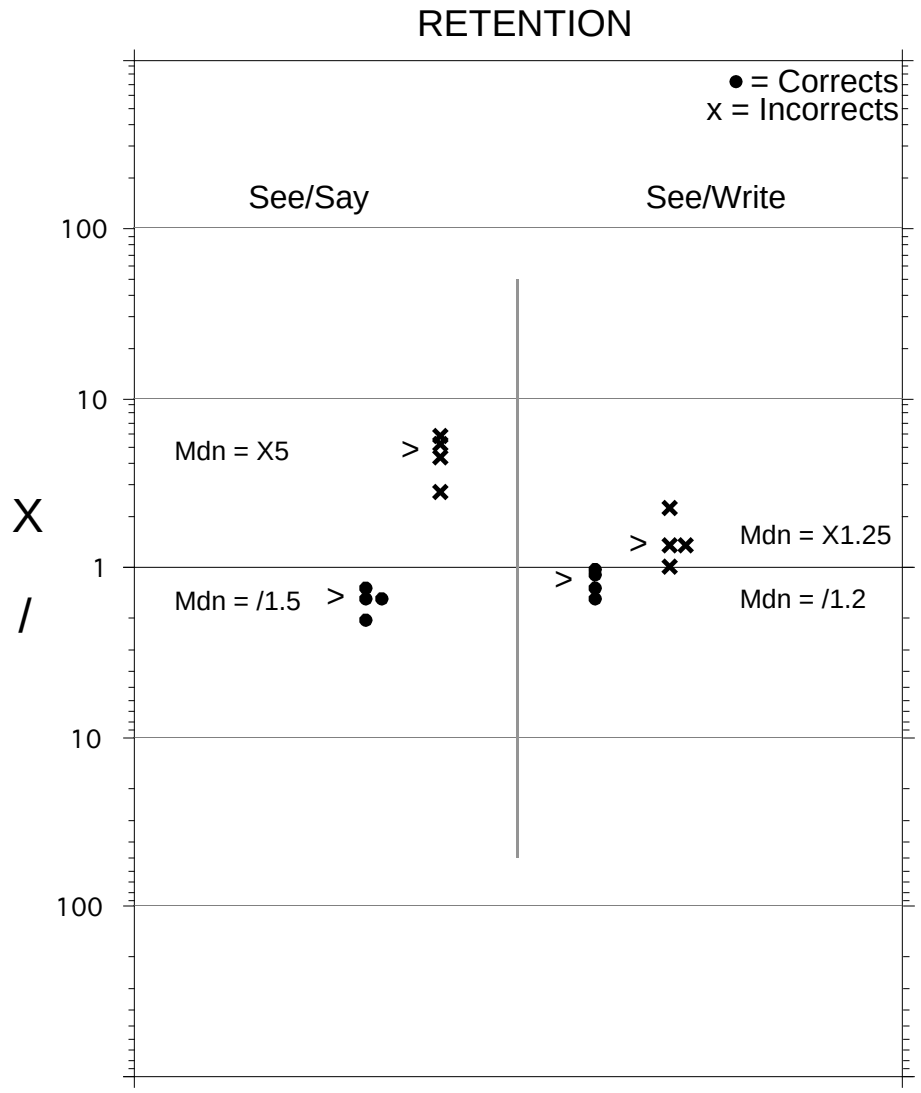

RETENTION
● = Corrects
x = Incorrects
See/Say
See/Write
100
10
1
10
100
X
/
Mdn = X5
Mdn = /1.5
Mdn = X1.25
Mdn = /1.2

**Figure 7: Median Frequency Jumps for Correct and Incorrect Responding in the Write to Say and Say to Write Test**

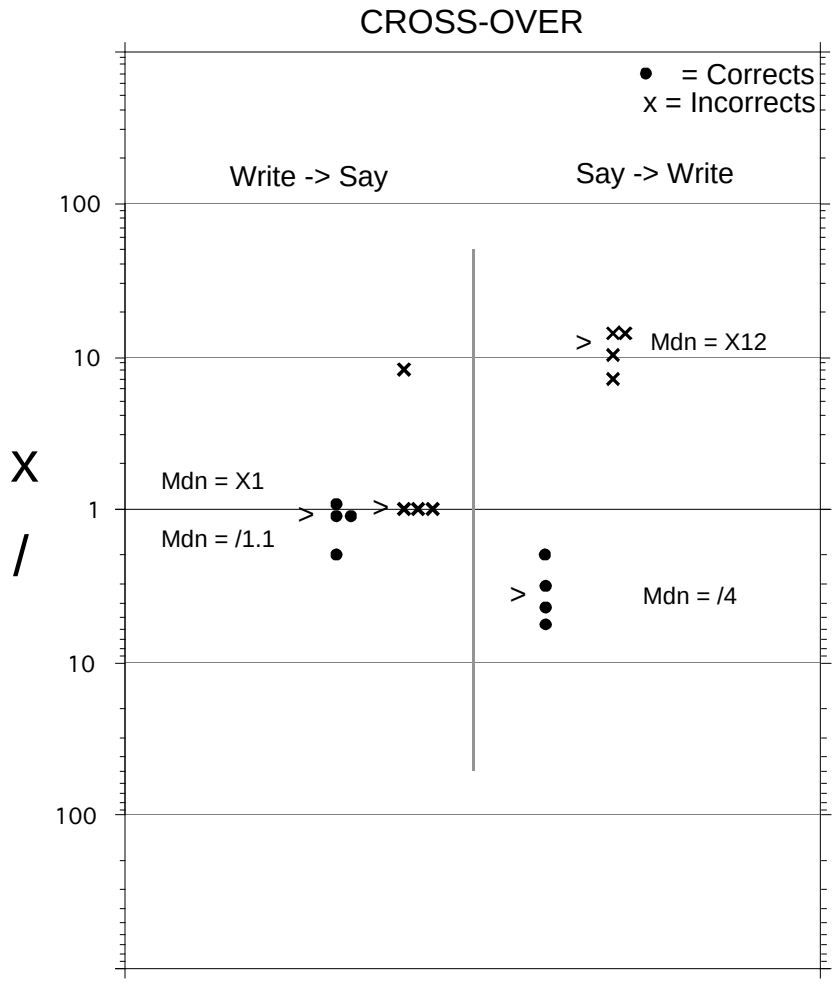
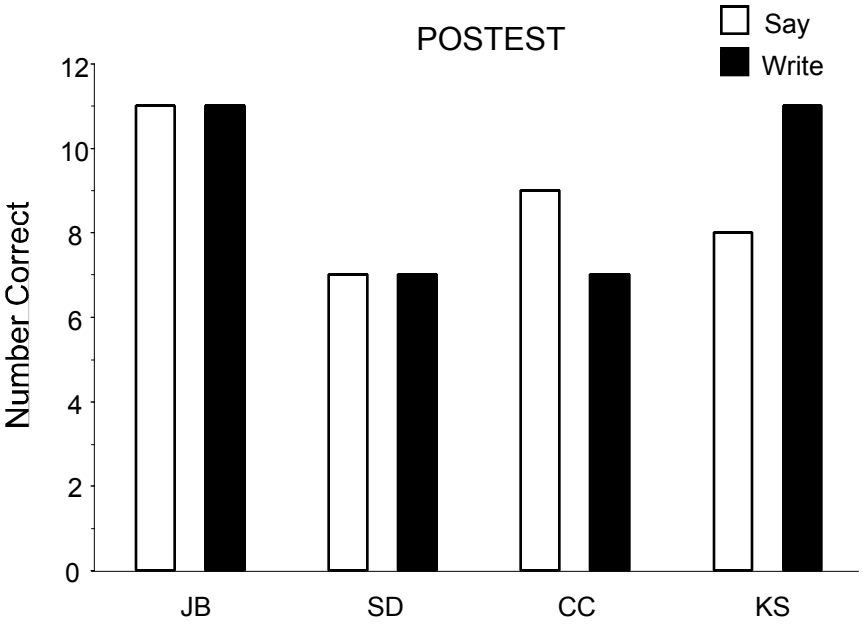

CROSS-OVER
= Corrects
x = Incorrects
Write -> Say
Say -> Write
100
10
1
10
100
X
/
Mdn = X1
Mdn = /1.1
Mdn = X12
Mdn = /4

**Figure 8: Number of Say and Write Responses for the Think/Say Post and Retention Tests**

# Think/Say


POSTEST
Say
Write
Number Correct
12
10
8
6
4
2
0
JB
SD
CC
KS

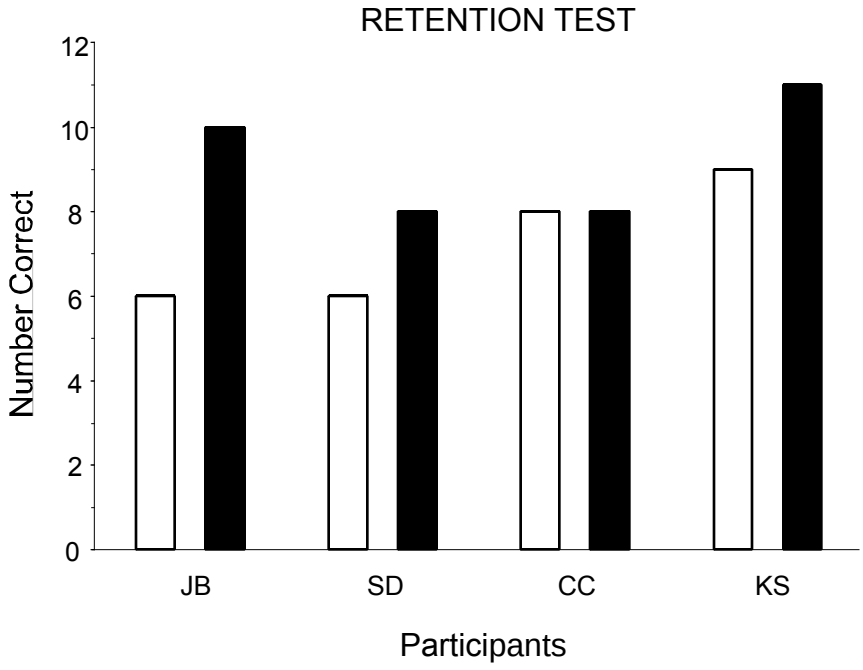

RETENTION TEST
Number Correct
12
10
8
6
4
2
0
JB
SD
CC
KS
Participants

**Figure 9: Number of Say and Write Responses for the Think/Write Post and Retention Tests**

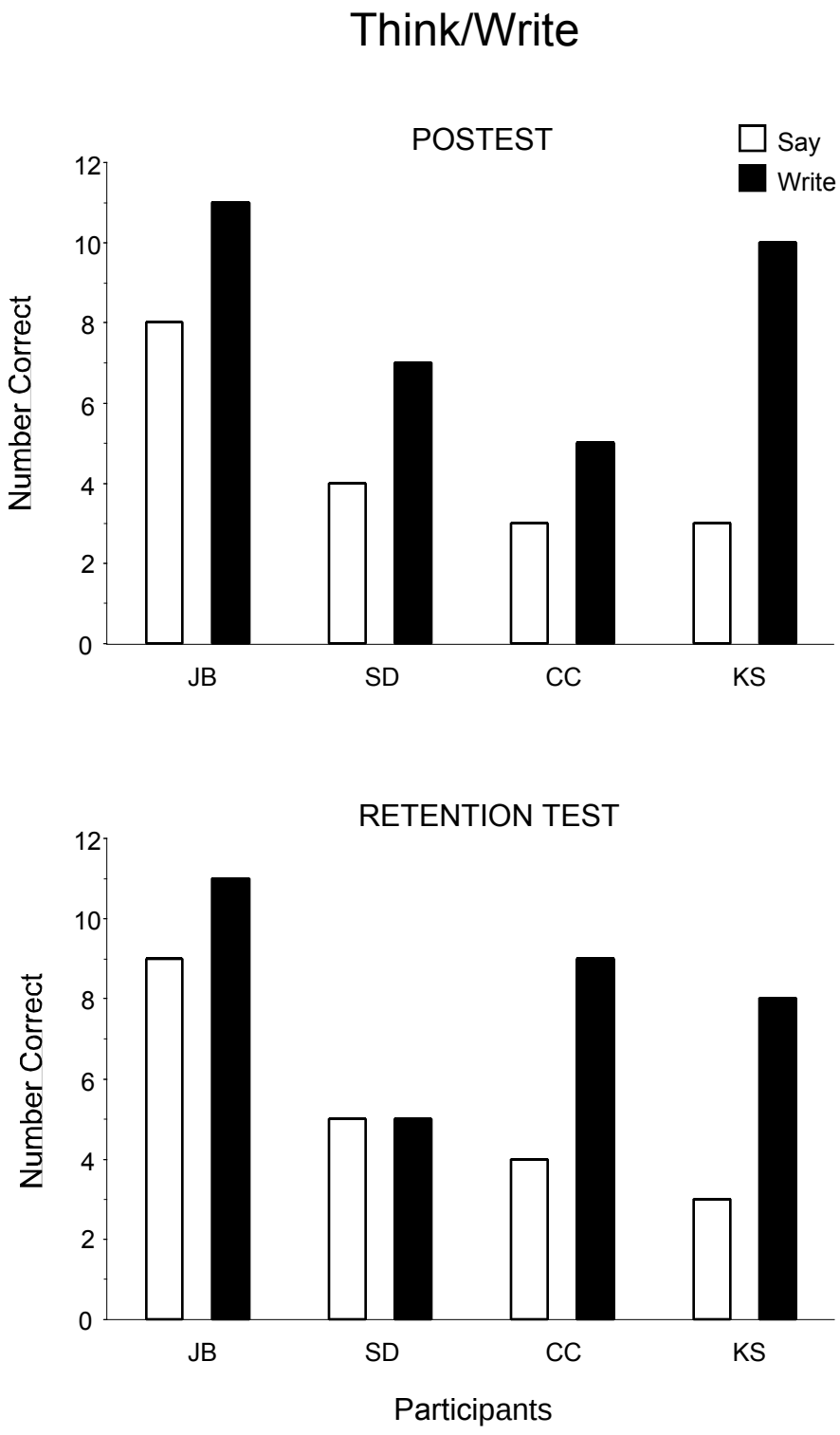
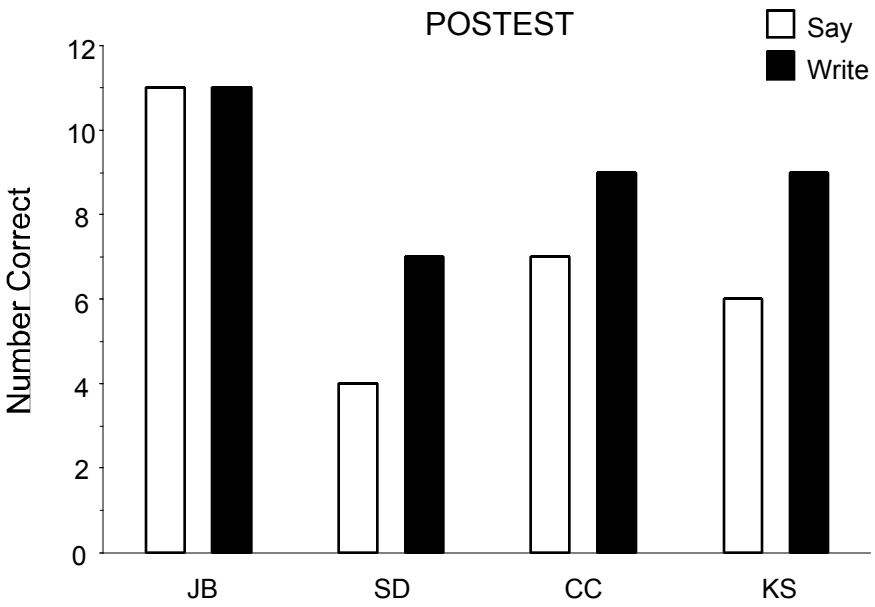
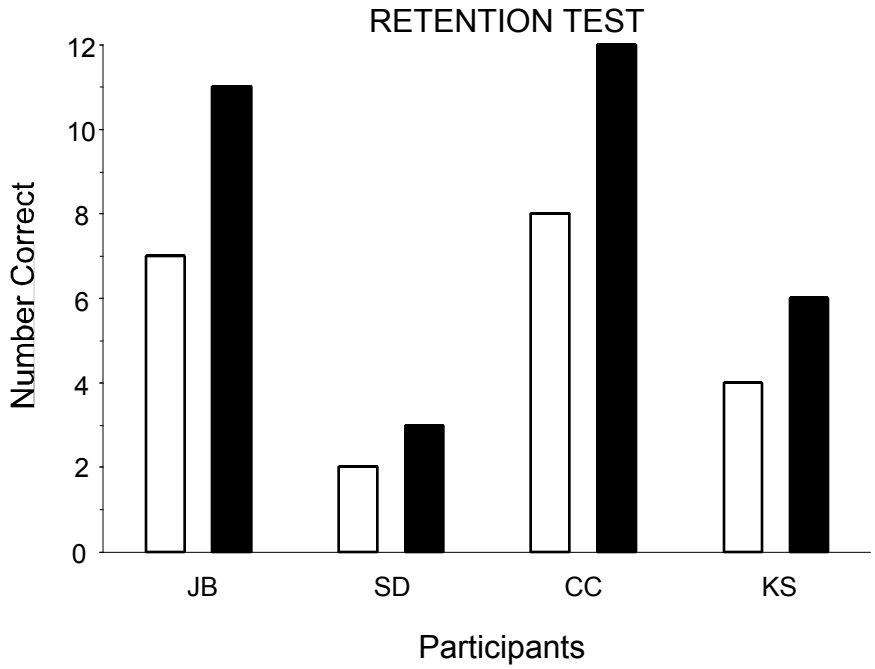

Think/Write
POSTEST
Say
Write
Number Correct
12
10
8
6
4
2
0
JB
SD
CC
KS
RETENTION TEST
Number Correct
12
10
8
6
4
2
0
JB
SD
CC
KS
Participants

**Figure 10: Number of Say and Write Responses for the See-name/Draw-symbol Post and Retention Tests**

# See-name/Draw-symbol



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