The Effect of a Multiple Acoustic Context on Recall of a Lecture Series

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Abstract

Previous literature has shown the following: (1) when material is learned in an acoustic context, or the presence of background music, the music becomes associated with the learned material (Smith, 1985); and (2) the use of multiple learning environments, or multiple contexts, improves memory for the material learned in those environments (Smith, 1982, and Smith and Rothkopf, 1984). Therefore, the purpose of this study was to explore the possible benefits of a multiple acoustic context on recall of a three day lecture series. Six groups of subjects heard a single repeated piece of background music (Single Acoustic Context condition, SC) for the entire lecture series. Another six groups heard a different piece for each lecture (Multiple Acoustic Context condition, MC). Science fiction stories presented on audiotape were used as the lecture material. Results showed that subjects in the MC groups scored significantly better, as predicted, than subjects in the SC groups. This finding supports the previous research on contextual enrichment, as well as the original hypothesis of this paper, that a multiple context effect can be induced successfully within one physical context using a multiple acoustic manipulation.

Acknowledgments

I would like to thank my advisor, Dr. Steve Smith, for his much needed and appreciated time and help in this thesis project. I am especially grateful for his guidance and advice on experimental design, data analyses, and thesis preparation. I would also like to thank Dr. Smith for the donation of the lecture series used in this study, his classic science fiction novels, and the use of his Human Cognition Lab, where I conducted the experiment.

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Certain aspects of a surrounding physical environment will facilitate or enhance recall of information encoded in that environment, and furthermore, testing the individual in that same environment will produce better recall than in a different environment. For example, if an individual studies some information in a particular room and is later tested for memory of the information, that individual should demonstrate a better memory for the information if tested in the same room, or context, than in another room (Smith, Glenberg, and Bjork, 1978).

That basic idea of context has been manipulated and studied in a wide variety of ways from state dependent (drug induced context - Eich et al, 1975) to inrinsic or word related context, and in physical settings from classrooms to ocean floors (Godden and Baddeley, 1975).

Some of the more interesting evidence found supporting context effects have been those studies concerning physical or environmental context. Godden and Baddely (1975) investigated how the change in physical environments from land to 20 feet below water affected performance on a recall test of 36 unrelated words. They found that word lists were best recalled in the environment in which they were learned. For example, word lists learned under water were best recalled when the subject was tested under water, and word lists learned on land were best recalled when the subject was tested on land.

An interesting twist in context research is the study of acoustic context. Rather than using the physical environment

to induce the context effect, the acoustic environment can be used as the context manipulation. Smith (1985), conducted a study in which subjects were presented with a word learning task followed by an immediate recall test and another recall test 48 hours later. During the imput, and final recall sessions, background music was either held constant, changed, or removed. Smith found that recall was better when the music presented during the learning session was reinstated rather than replaced by different music or the absence of music.

Recent studies have also explored the use of multiple room, or multiple environmental contexts, where the effect of several learning environments, rather than a single learning environment is studied.

According to Smith (1982), subjects recall for a list of words is better if the list of words is subdivided with each group of words learned in different rooms than if that same list of words is presented in only one room. Smith explained, "the multiple learning rooms become associated with the different sublists during learning and subsequently act as memory landmarks that guide the course of retrieval (p. 405)."

Clearly, physical context, and in particular, multiple physical contexts, can play an important role in recall memory. But how can physical context be manipulated for practical use in learning situations? More specifically, how can one effectively manipulate context in the classroom or in the study environment? Smith (1982) demonstrated that multiple environmental contexts

improved performance on recall tests when a list of words was subdivided and learned in separate rooms. In a more practical application of multiple room context, Smith and Rothkopf (1984) showed the positive effects of environmental context on massed instruction - situations where the student has to learn an entire set of course material in a short time, i.e. a seminar. Smith and Rothkopf used an eight hour statistics course divided into four videotaped lessons, and presented these lessons in four conditions. The first set of conditions were time massed (material presented in one day). Group 1 received all the lessons in one room, while Group 2 received the four lessons in four different rooms. The second set of conditions were time spaced. Group 3 received the lessons in one room, but the presentation was spaced over four days. Group 4 received the four lessons in four different rooms over a four day period. Students were given brief exercises on the material after each session, but they were not informed of the final test given at a post experimental session (a new room not used in any of the experimental conditions). The final test included cued recall (specific retrieval cues were given), general recall, matching and computations. Students in the multiple room context scored higher on the general recall portion in both massed and spanned time intervals. No context effect was found on the other areas of the test. Smith and Rothkopf explained that contextual enrichment improved recall because of its effect on accessibility of information rather than availability of information.

Contextual enrichment acts to organize information in segments which correspond to the various environments. This organization increases the accessibility of the information, not the availability. Increased availability due to contextual enrichment would have resulted in superior performance in all areas of the test, not just general recall.

If a multiple context manipulation can produce improved recall for a lecture series in an experimental situation, perhaps the same results could be found in a real classroom situation. There is, however, at least one outstanding problem with a multiple context design for practical classroom situations. How does one establish multiple learning contexts within one classroom? The use of multiple rooms, as in the Smith and Rothkopf study is often infeasible for a real classroom situation. It would be quite time consuming and expensive to use more than one room for instruction, and realistically, no educational institution has the resources or the facilities to provide such a service. One possible way to solve this problem is to explore the use of a multiple acoustic manipulation. Rather than vary the physical environment, or context, for each lecture, vary the acoustic environment for each lecture. Smith (1985) demonstrated that a musical background can induce context-dependent memory. In theory then, the use of a multiple acoustic context manipulation should produce results similar to the Smith and Rothkopf multiple room study.

The purpose of this study was to explore the effect of

multiple acoustic contexts on recall of a time spanned lecture series. The goal was to design an experimental situation that modeled a real classroom situation to see if a multiple acoustic contest manipulation could produce better recall scores than a single acoustic context. Another issue explored in this study was subject familiarity with the musical contexts. What type of musical background best induces a context effect; music that the subjects recognize or music that they have never heard before? Furthermore, does instruction (i.e., explaining to the subjects the theory of context effects) prior to a lecture aid in context utilization?

Method 1

Unlimited Subjects

Eighty volunteers (59 females and 21 males) from introductory psychology classes at Texas A&M University fulfilled 4h of experimental credit with their participation in this study.

Materials

Lecture Series. The lecture series presented to the subjects consisted of three audiotaped science fiction stories read by a female voice:

Lecture I. "The Nine Billion Names of God," by Arthur C. Clarke.

Lecture II. "The Great Slow Kings," by Roger Zelazny.

Lecture III. "The Man who Loved the Faioli," by Roger Zelazny.

These particular stories, written from 1953 - 1967, were selected to ensure that subjects' familiarity with the lecture material would not affect recall scores. In fact, only one subject had heard these stories prior to participation in this experiment. Each audiotaped lecture was approximately 20 minutes in length.

Music. Three selections of music were used to establish the acoustic context for the lectures:

A. "The Four Seasons - Spring Movement," by Vivaldi.

B. "The Entertainer," by Scott Joplin.

C. "Variations on a Theme by Mozart," played by John Williams.

Each selection had a simple, repeating melody line with no lyric or vocals. Selections A and B were familiar to the subjects; each subject had heard these selections at least once prior to

participation in the experiment. Selection C was unfamiliar. Only one subject had heard selection C prior to participation in the experiment. Volume levels for the music were set at 55 dB. Wolfe (1983), in a study exploring the effects of music loudness on task performance found that music volume up to 90 dB did not adversely affect task performance.

Recall Test. Three timed recall tests (seven minutes each - one test for each lecture) were administered on the fourth day of the experiment. The use of three separate tests was necessary in order to reinstate the acoustic background of the lectures for those subjects in the Multiple Acoustic Context conditions. Each test was broken down into three questions (Appendix A). Subjects were instructed to list their responses under each question. To establish an accurate recall score, each test was compared to a master list of possible responses for each story, or lecture. The number of correct responses established the recall score for each test.

Design

The subjects were divided into 12 groups (four to eight subjects per group) and assigned to the 12 conditions summarized in Table 1.

Insert Table 1 about here

The design was a 2 x 2 x 3(Music x Instruction x Counterbalancing) factorial. All variables were between subjects variables. Music was Constant or Varied. Instruction was Yes or No, and Counterbalancing was (Music A then B then C) or (Music B then C then A) or (Music C then A then B). The two main variables of interest were the Multiple Acoustic Context variable (MC) or Varied conditions and the Single Acoustic Context variable (SC) or Constant conditions. Within the MC and SC conditions there were two levels of instruction. In the Instruction - Yes groups, the concept of context effects and the presence of the music was explained to the subjects. In the Instruction - No groups, no explanations were given.

Procedure

The experiment spanned a four day period with three days of lecture and one day of testing. Each lecture period lasted 30 minutes. The test session also lasted 30 minutes. The experiment was conducted in a 10 x 15 sq. ft. room. Subjects were seated in a horseshoe position around a cassette player containing a lecture tape. The music tapes were played via a stereo system approximately five feet from the cassette player. Following the procedure for Group 1 (table 1), subjects would enter the experimental room on the first day of the experiment and receive instruction about context effects and the acoustic context manipulation in this study. They would then listen to Lecture I while music selection A played on the stereo. On the second

day of the experiment Group 1 would listen to Lecture II with music selection B playing in the background. On the third day of the experiment, Group 1 would hear Lecture III with music selection C. On the fourth and final day, Group 1 returned to take three seven minute recall tests. During the first time period, subjects worked on the Lecture I recall test with the reinstatement of music selection A. During the second time period, they worked on the test for Lecture II with the reinstatement of music selection B, and so on.

Smith (1985), in a study using musical backgrounds as context manipulations, found that the reinstatement of the acoustic context during a recall task improved recall. Therefore, to enhance performance on the recall tests in the present study, all groups had the benefit of reinstatement

Results

A 2 x 2 x 2 (Number of Musical Contexts x Instruction x Sex) analysis of variance (ANOVA) was computed for Total Score on the three recall tests. Number of Musical Contexts (NMusic) was either Multiple context (MC) or Single Context (SC). Instruction was either Yes or No, and Sex was Male or Female. There was a significant effect for NMusic, $F(1,72 = 23.67$, $p < .001$, MSe = 131.03. The subjects in the MC Groups scored an average of 10.4 points higher than those subjects in the SC groups, which translates into a 32.6% difference in total recall scores between

the MC groups and the SC groups (Figure 1). There was also a

Insert Figure 1 about here

Significant effect for sex, $F(1,72) = 5.13$, $p = .02$, MSe = 131.03 with female subjects scoring better across both SC and MC groups (Figure 2).

Insert Figure 2 about here

Additionally, a significant interaction was found between INSTR and Sex, $F(1,72) = 10.09$, $p = .002$, MSe = 131.03 (Figure 3). There was not a significant interaction between INSTR and NMusic, $F(1,72) = .27$, $p = .60$, MSe = 131.03 (Figure 1).

Insert Figure 3 about here

A 2 x 2 x 2 (NMusic x Instruction x HI/LO) ANOVA was computed, again for Total Score on the three recall tests. HI/LO was either High (Total Score > 36) or Low (Total Score < 36). The interaction between INSTR and HI/LO was not significant, $F(1,72) = 2.07$, $p = .15$, MSE = 74.17. The pattern of the scores,

however, were similar to the INSTR and SEX interaction (Figure 4).

Insert Figure 4 about here

The t-test analyses showed that there was no significant effect for music type in the SC groups (Familiar - A and B, and Unfamiliar - C); comparing A and B, $t(24) = .86$, $p < .05$; comparing A and C, $t(24) = -.37$, $p < .05$; and comparing B and C, $t(24) = -1.11$, $p < .05$.

Also there was no significant effect for counterbalancing, or order of musical context presentation in the MC groups (C1 = A then B then C; C2 = B then C then A; and C3 = C then A then B); comparing C1 and C2 $t(25) = .07$, $p < .05$; comparing C1 and C3, $t(26), = .06$, $p < .05$; and comparing C2 and C3, $t(25) = -.03$, $p < .05$.

A final 2 x 2 x 2 (NMusic x Sex, INSTR) ANOVA was computed using separate scores for the three recall tests rather than the Total Score. A significant difference was found between the three scores, $F(2, 144) = 31.07$, $p < .001$, MSE = 20.17, with recall scores on the third test (Story 3) higher across both SC and MC groups than recall scores on the first and second tests (Story 1 and Story 2 - Figure 5).

Insert Figure 5 about here

Discussion

The superior performance of the MC groups on total recall for the lecture series is the most important finding of this study for several reasons. First, it supports the findings of Smith (1982) and Smith and Rothkopf (1984), where the use of a multiple context manipulation resulted in higher recall for a memory task. Second, musical backgrounds were used successfully as the context manipulation. This supports the original hypothesis, that a multiple context effect can be achieved using acoustic rather than physical environments. Third, the sizeable difference between the recall scores of the MC and SC groups suggests that the multiple acoustic context manipulation, and not some other confounding variable, caused the higher recall scores of the MC groups. Finally, the experimental condition in this study approximated a classroom situation. Subjects reported daily for lectures, and their memory for those lectures was then tested. That the multiple context manipulation resulted in higher recall in both this pseudo-classroom situation and in a previous study using a classroom learning situation (Smith and Rothkopf, 1984) suggests that further research in the area of multiple context effects should focus on the practical application of contextual enrichment in real learning situations.

Another interesting finding was the significant effect of sex. Across all groups, both SC and MC, females had consistently higher scores than males. Additionally, there was significant

interaction between sex and instruction. Instruction seemed to have an adverse effect on male recall scores, with males in the instruction groups scoring much lower than males in the non-instructed groups. The opposite was true for females. Females in the instructed groups had slightly higher recall scores than females in the non-instructed groups. There are several possible explanations for this trend. According to the report of Durden-Smith and Semoine (1982), there are sex differences in information gathering styles. Males tend to be more narrowly focused and less sensitive to situational variables. Females, on the other hand, are sensitive to context, and are capable of picking up peripheral information, or focusing on several things at one time. The males in the present study, then, being narrowly focused, could have been distracted by the instruction, shifting their focus away from the lectures and onto the music. The females, being able to focus on several things at one time, were not distracted by the instruction. In fact, according to this theory, they would have been able to use the instruction to enhance their scores.

Another, less speculative explanation is the possibility that the low number of males in this experiment contributed to the sex effects found. There were 59 females and only 21 males who participated in this experiment. A larger number of male participants could have canceled the effects for sex. Then again, a larger sample of males could have enhanced the already significant effects for sex.

A final hypothesis was explored for the sex/instruction interaction. Recall scores were higher for females across all groups. Perhaps the interaction between sex and instruction really reflected an interaction between high scoring subjects and low scoring subjects, with the females representing high scorers and the males representing low scorers.

The high score-low score/instruction interaction was not significant but the pattern of scores was similar to the sex/instruction interaction. High scorers performed slightly better in the instructed conditions, and low scorers performed better in the non-instructed conditions. Again, this interaction was not significant, making the high score-low score explanation speculative as well.

An original consideration in this thesis was the issue of subject familiarity with the musical background selections. Would the subjects' familiarity with the music selections affect recall scores? Apparently not. There were not significant differences between the scores of subjects who heard familiar pieces of music and those who heard the unfamiliar music selection.

When the recall scores for the three individual lectures were analyzed, a long-term recency pattern emerged. The recall scores for the last lecture were higher across all groups than the recall scores for the first and second lectures. This resembles what in recent years has been labeled a long-term recency effect. Recency effects are generally associated with

short term memory tasks. Recency effects have also been observed in memory tasks requiring the use of long term memory (Bjork and Whitten, 1974). The twenty-four hour period between the last lecture and the recall tests in the present study required the use of long term memory. The fact that recall scores on the last lecture were higher than the first two lectures would seem to support the existence of long-term recency effects. The lectures, however, were not counterbalanced; therefore the possibility of an effect for lecture order cannot be ignored.

In regard to the actual application of contextual enrichment in real lecture situations, there are several issues which need to be examined: a theory of disruption verses context utilization, the effect of context manipulations on recognition memory, and the issue of field dependency.

The results of this experiment, and those conducted by Smith (1982) and Smith and Rothkopf (1984), indicate that memory is improved through the use of multiple learning environments. Strand (1970), however, suggests that the improved performance on recall tests in change of context studies is not so much a function of the environment as it is a function of the disruption from moving from one environment to another. She demonstrated this disruption effect by presenting a two list learning task with a free recall test under two conditions. In one condition, the subjects learned one list in one room and then moved to another room to study the second list. In the second condition, the subjects simply stepped out of the room for a few minutes

after the first task, and returned to the same room for the second task and subsequent recall test. The change of context group was returned to the first room for the recall test. She found that in both conditions the subjects performed equally well on the recall test, and thus suggested that "room change does not support the notion that contextual associations are important in free recall (p. 205)." Smith, Glenberg and Bjork (1978), however, in a similar study, controlled for disruption by separating the learning tasks and recall tests for all subjects over a three day period, equally disrupting the subjects and found that the changed context condition still produced superior recall.

A more pertinent problem in the area of context research concerns the type of memory affected by context manipulations. All studies thus far mentioned have concentrated on the connection between context and recall memory. However, studies concerning recognition have usually failed to show a similar connection between context effects and memory. For example, Wickelgren (1975) found no evidence of a state dependent context effect on recognition. Using a word and pictoral recognition test after a learning task, he discovered that there was not a difference between retention abilities of those subjects in a continuous condition (alcohol encode-alcohol retrieval) and those in a subsequent condition (alcohol encode-sober retrieval). "The failure to find such an effect argues that state dependent retrieval played no significant role in the present experiment in

agreement with previous studies using recognition memory (p. 388)." In a land and underwater study, Davis (1975), also failed to find that environmental context had an effect on recognition memory.

One interpretation of the apparent lack of environmental context effects on recognition is that the intrinsic nature of the recongition test provides a much stronger context than the environmental context, thus cancelling out the extrinsic, or environmental context effect.

Godden and Baddely (1980), suggest that recognition memory is primarily a function of intrinsic context - the presence of the word itself in the recognition test acts as a much stronger context than the surrounding environmental context. They propose that the environmental context has a "purely arbitrary relationship to the material learned. As such, it does not determine the interpretation of the material, and hence, can contribute nothing to the already powerful cues presented by the physical presence of the words to be remembered (p. 104)."

Smith (1986), however, asserted that recognition is subject to environmental context effects. Smith found that restricting the use of good memory cues on a recognition task forced subjects to rely more heavily on contextual cues. The use of good cues was restricted by using a learning task which prevented the storage of meaningful associations among the list words.

Contrary to Godden and Baddeley's hypothesis (1980), Smith suggested that context dependent recognition should not be

explained in terms of intrinsic or extrinsic context, but in terms of the type of processing used during input.

In the Smith and Rothkopf (1984) study, the improved recall due to the multiple room context was prevalent only in field dependent subjects - "subjects who perceive a stimulus in relation to the background or field in which the stimulus is embedded (p. 345)." The entire group of subjects was tested prior to the experiment for field dependency using the Group Embedded Figures Test. The field independent subjects (those who perceive a stimulus independent of a background) did not benefit from the multiple room context.

Students were not tested for field dependence in the present study, but field dependence is certainly an important issue to explore in a discussion of applying contextual enrichment in a classroom situation. Perhaps only a certain group of students, field dependent students could realistically benefit from contextual enrichment.

Conclusion

The results of this study, combined with the findings of previous studies provide three conclusions: (1) the use of multiple context manipulations can improve memory, at least recall; (2) the use of a multiple acoustic design can produce a multiple environmental context effect within one physical environment; and (3) contextual enrichment can be successfully studied, if not applied, in actual learning situations.

There may be some problems with the actual use of contextual enrichment in classroom or lecture situations, specifically, the problems of recognition memory and field dependence. While Smith (1986) demonstrated that recognition was context dependent, his results are limited to short-term memory tasks.

Beyond the issue of the type of memory contextual enrichment aids is the issue of the type of student contextual enrichment aids. Previous literature indicates that multiple contextual enrichment improved recall for field dependent subjects only (Smith and Rothkopf, 1984). Additionally, the results of the present study showed sex differences in instruction and context utilization. Such findings suggest that if contextual enrichment could be used in the classroom, it may benefit certain types of students more than others.

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MUSIC

	Varied						Constant					
	Instruction						Instruction					
	Yes			No			Yes			No		
Lecture I	A	B	C	A	B	C	A	B	C	A	B	C
Lecture II	B	C	A	B	C	A	A	B	C	A	B	C
Lecture III	C	A	B	C	A	B	A	B	C	A	B	C
Group	1	2	3	4	5	6	7	8	9	10	11	12

MUSIC

A. Spring Movement-"The Four Seasons" by Vivaldi

B. "The Entertainer" by Scott Joplin

C. "Variations on a Theme By Mozart" by John Williams

LECTURES

I. "The Nine Billion Names of God" by Arthur C. Clarke

II. "The Great Slow Kings" by Roger Zelazny

III. "The Man Who Loved the Faioli" by Roger Zelazny

Table 1 - The Design of the Music and Lecture Presentation for the Multiple and Single Context Conditions.

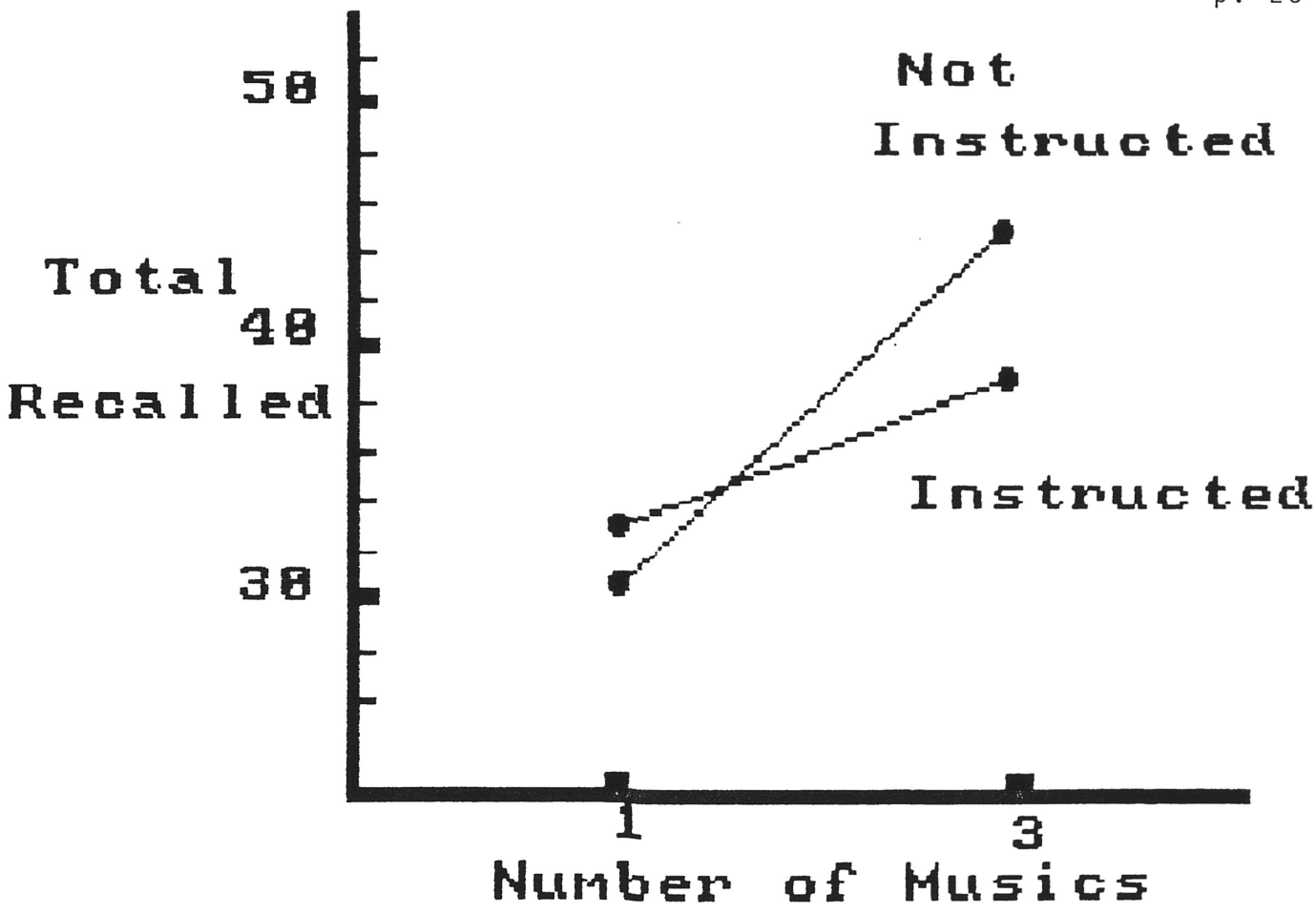

Figure 1 - Total Recall as a Function of Number of Musics and Instruction.

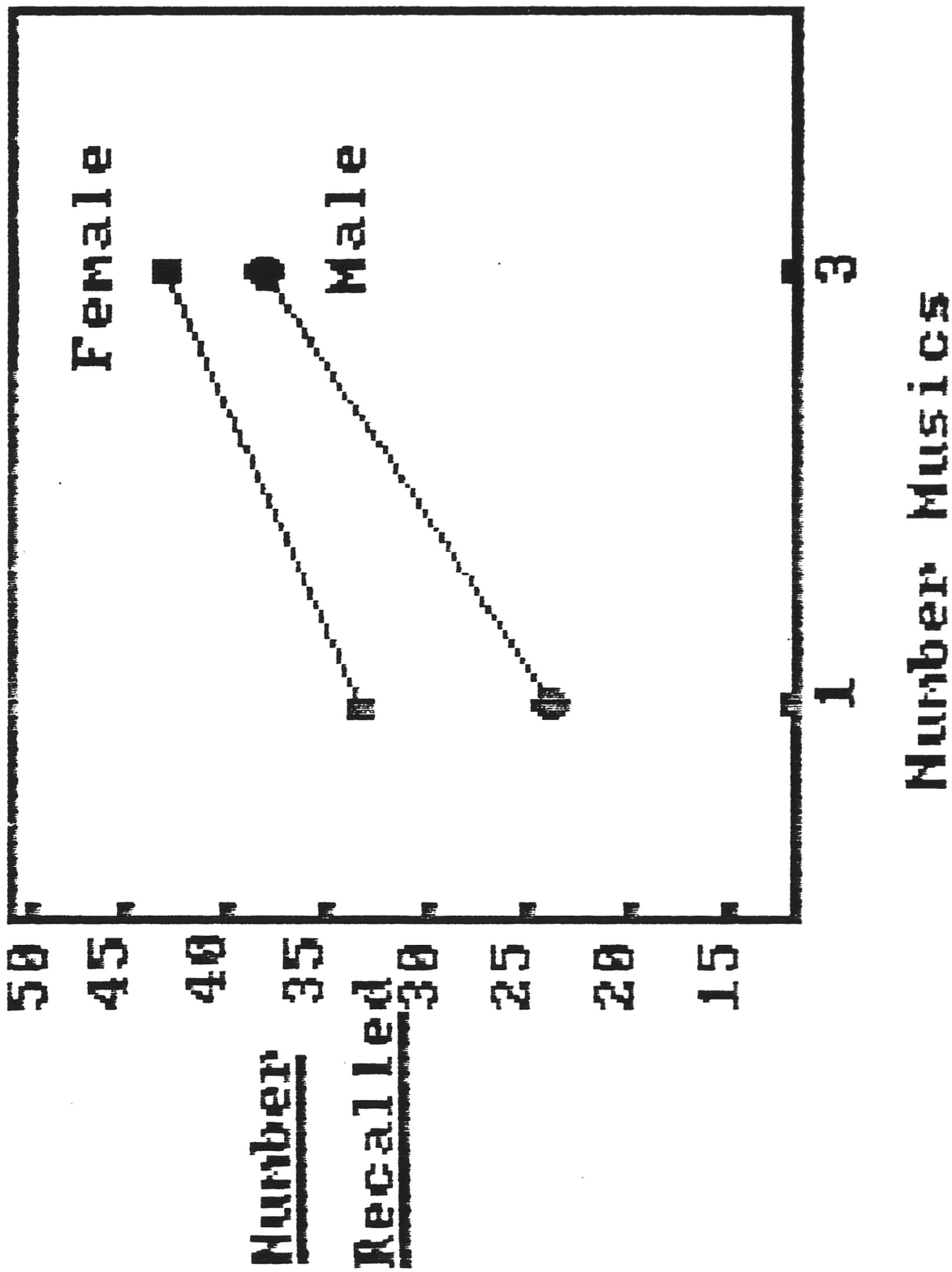

Figure 2 - Total Recall as a Function of Number of Musics and Sex.

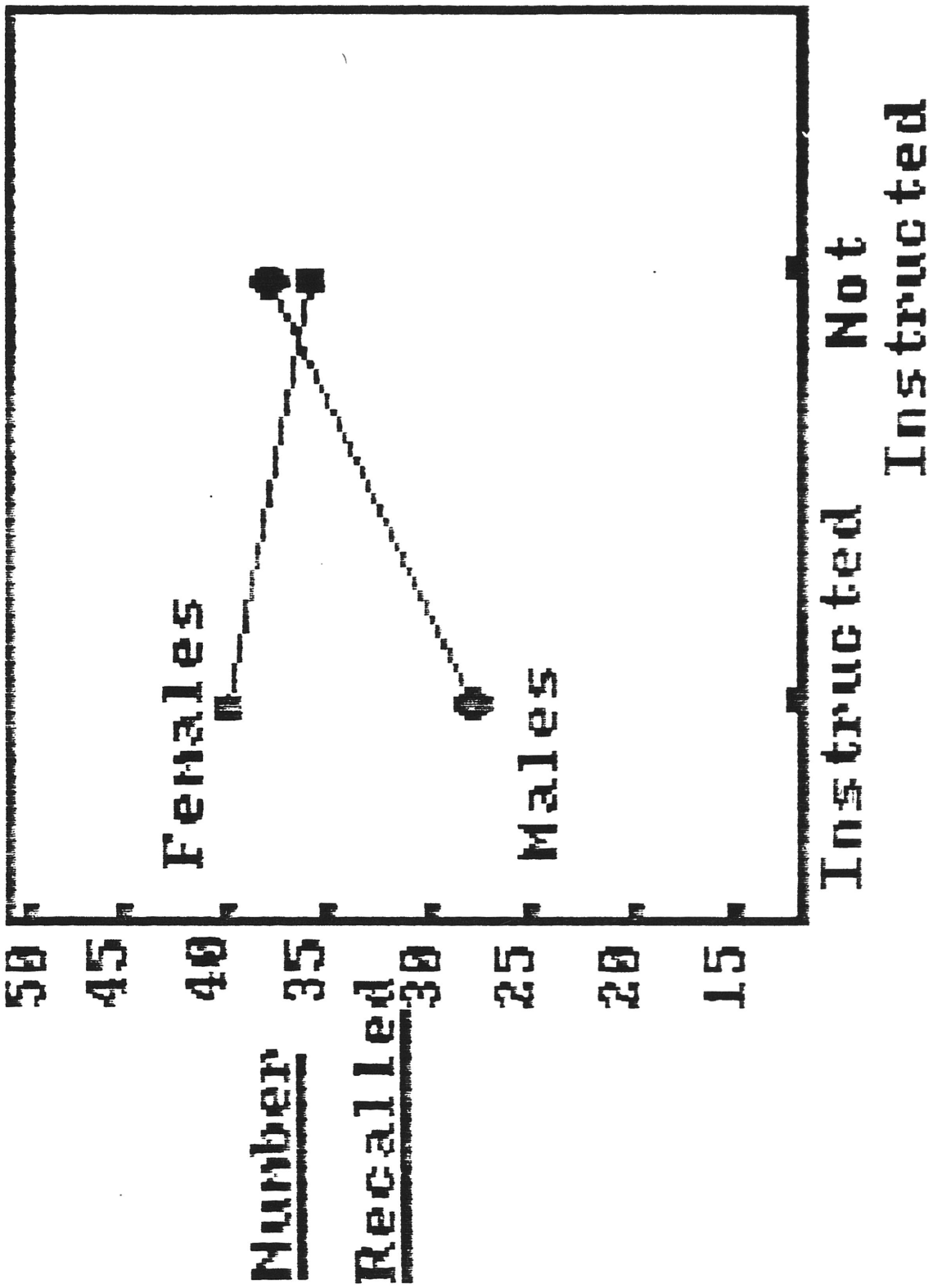

Figure 3 - Total Recall as a Function of Instruction and Sex.

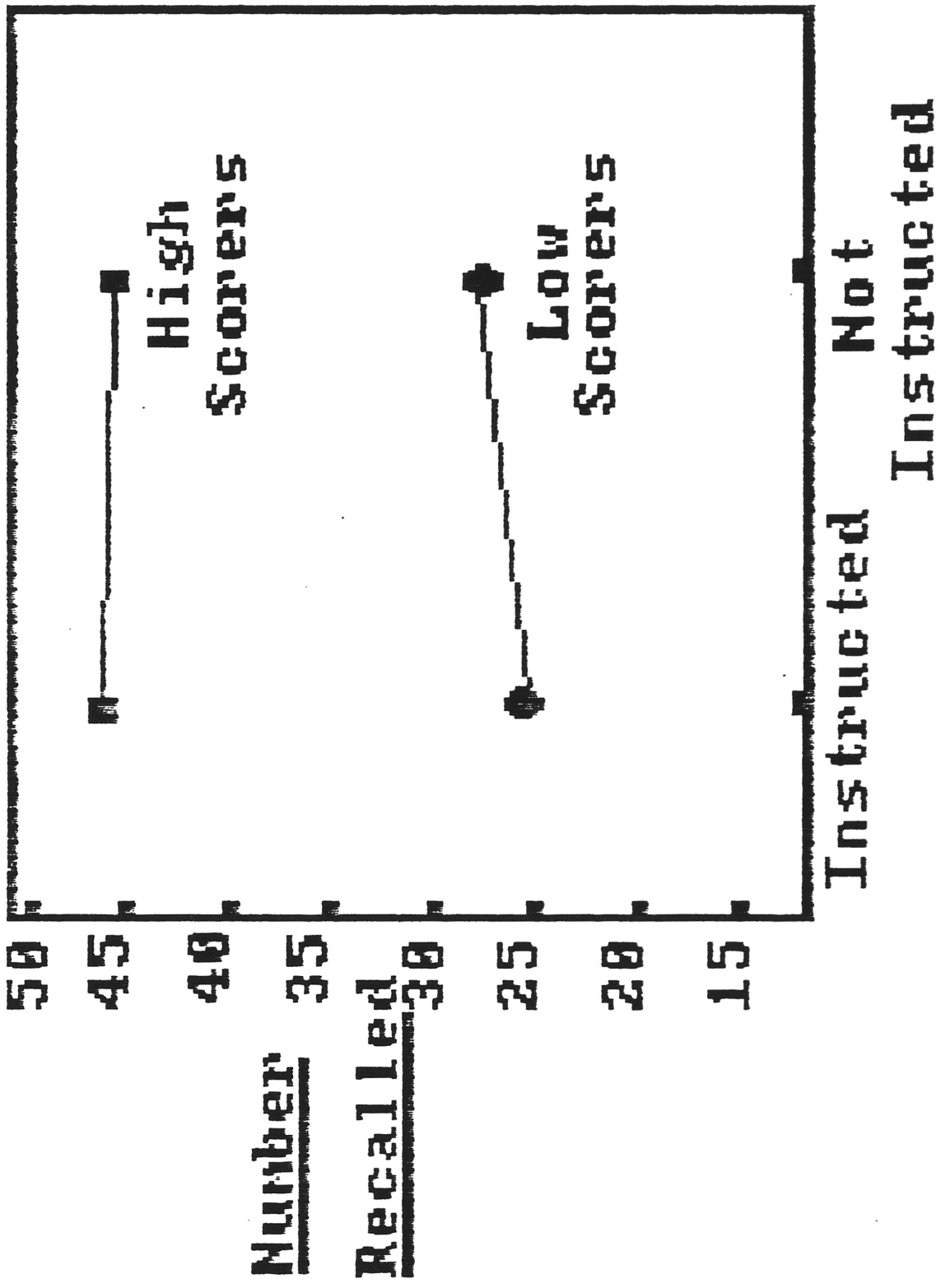

Figure 4 - Total Recall as a Function of Instruction and HI/LO.

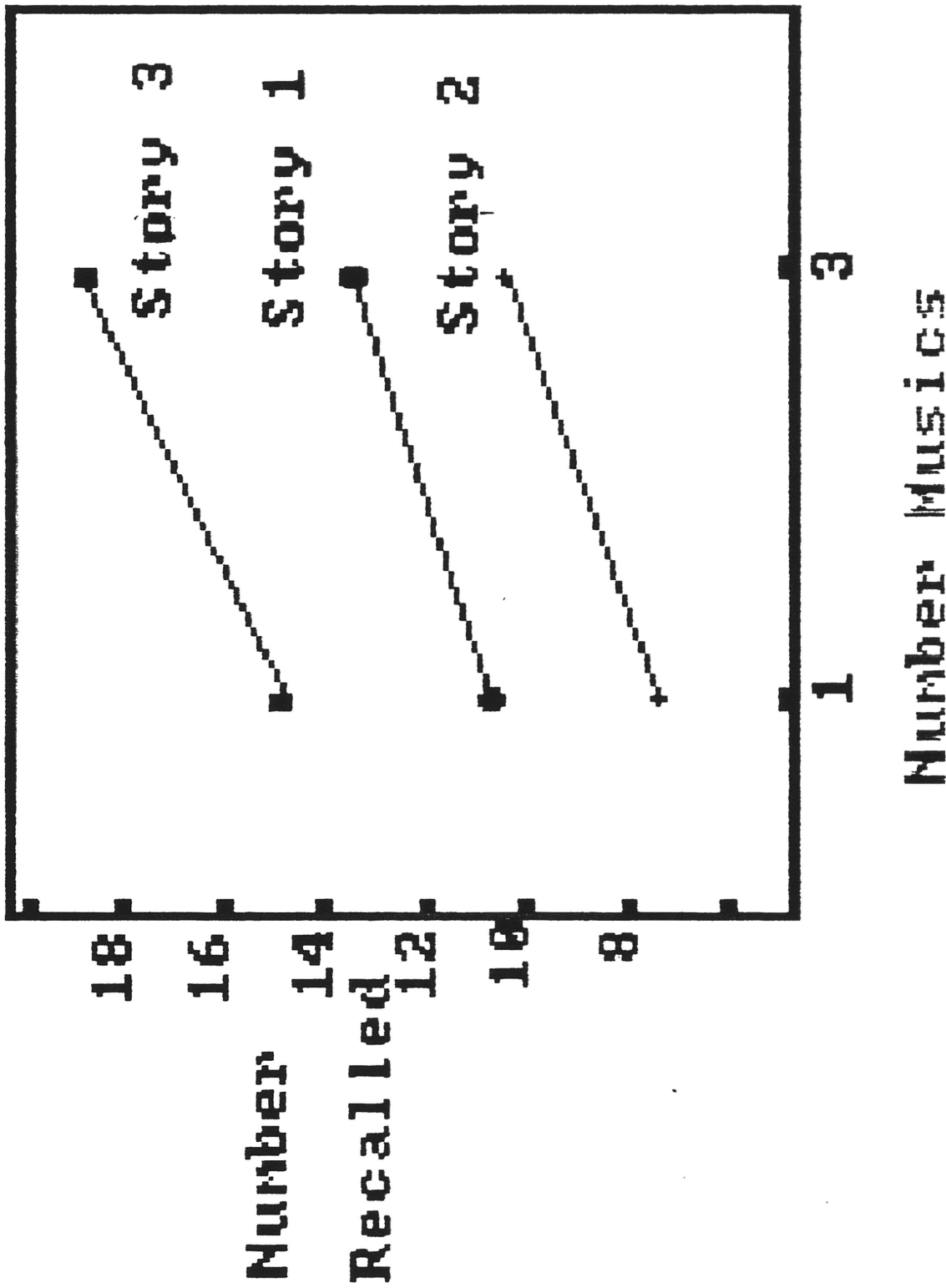

Figure 5 - Recall Scores as a Function of Number of Musics and Individual Lectures, or Stories.

INSTRUCTIONS

You will have seven minutes to write down everything you remember about Lecture I. Place your responses in the categories below. Please number your responses within each category. Use the back of this sheet for any additional responses. Guess, even if you can't remember exact names.

1.) The title of the story from Lecture I:

2.) The names of characters in the story from Lecture I:

3.) The names of places or things in the story from Lecture I:

4.) The plot, story line, or any other details you can remember about the story from Lecture I: