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Heart rate change was used as the index of the orienting response (OR) of 102 kindergarten children. Heart rate change was measured by recording heart rate upon the presentation of tones. 15 similar tones followed by a different, 16th tone, were used. From this data the children were divided into high, medium, or low orientors. Following the "OR" testing session, 96 subjects received two pictorial analogues of verbal discrimination tasks. Subsequently, 65 subjects received a paired-associate (P-A) task. Learning on these tasks, when related to "OR" classification, showed that low "OR" males and medium "OR" females performed best, while medium "OR" males and low "OR" females performed worst. This finding was significant for the P-A task, indicating a relationship between "OR" classification and learning performance on this particular P-A task. It is difficult to explain the fact that performance was reversed between the sexes. (WD)

# THE RELATIONSHIP OF INDIVIDUAL DIFFERENCES IN THE ORIENTING RESPONSE TO COMPLEX LEARNING IN KINDERGARTNERS

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The Orienting Response is usually considered to involve a constellation of physiological processes that is brought about by a change of stimulation in the environment. Some of the indices that have been used to measure this phenomenon are digital vasoconstriction along with cephalic vasodilation (Sokolov, 1963), GSR magnitude (Raskin, 1963) and heart rate deceleration (Chase; Graham & Graham, 1967).

A few experimenters have investigated the effects of individual differences in the orienting response (OR) in relation to conditioning and complex processes. The empirical work has been conducted with adults who have been classified as either "High" or "Low Orientors" on the basis of their physiological responses to a change in stimulation in the environment.

The OR is generally studied from one of two approaches. The first approach stems from the work of Sokolov (1963) that investigates the hypothesis that the occurrence of an OR enhances stimulus reception both within and across sensory modalities. The second area of research involves the relationship of the OR to established areas of behavioristic interest such as conditioning, learning, and reinforcement. It is currently hypothesized that the occurrence of an OR is necessary for the establishment of conditioning. It is also implied that the OR is closely related to the concepts of arousal and reinforcement. In addition to the assumption that the OR is related to learning, Maltzman and Raskin (1965) have also assumed that there is a wide range of individual differences in the magnitude of the OR that is reliably evoked in different subjects who are receiving the same stimulus conditions. They have also hypothesized that the OR is related to the

discrimination of such complex stimuli as words in addition to raising the sensitivity of sensory analyzers.

Raskin (1963) studied the relationship of individual differences in the OR and performance on a semantic conditioning and generalization experiment. GSR was used as the conditioned response. The OR was operationally defined as the magnitude of the GSR evoked by the first UCS, a burst of white noise. High and Low Orienting Subjects were identified on the basis of their GSR Magnitude. It was established that High Orientors showed reliably greater conditioning and semantic generalization than Low Orientors.

As the authors point out, it is necessary to have different measures of the OR and learning in order to establish any kind of generality about the relationship of the OR to learning.

Other investigators have reported the relationship of individual differences in the OR and performance on a paired-associates learning task. Belloni (1964) classified subjects into High and Low Orientors on the basis of the magnitude of their GSR to a word. The performance measures used were two paired-associate lists, classified as "easy" and "difficult". It was hypothesized that the OR could be viewed as an index of a "discriminative ability" and that High Orientors would learn both lists more quickly. The authors argued that those conceiving of the OR as a measure of drive would predict that High Orientors would do better on the easy list and that Low Orientors would do better on the difficult list. When the results were investigated within each sex, it was found that High OR males learned the difficult task reliably faster than the Low OR males. The authors concluded that the OR was related to discriminative ability and that it could not be viewed as some kine of drive index, since Manifest Anxiety Scores could not

be used to predict performance on the paired-associates list.

Nies (1964) used the same P-A lists in a similar experiment and categorized Subjects into High and Low Orientors on the basis of magnitude of the GSR to a 90 dB noise. Only male subjects were used. The High OR group was superior to the Low OR group on both lists when response speed was used as a measure of performance. The High OR group also required fewer trials to criterion than the Low OR group on the difficult list.

There is some evidence, then, that individual differences in the OR can be used to predict performance in a highly unrelated situation. It was the purpose of the present study to extend these conclusions in several possible directions.

First, would there be any relationship between the OR and learning in subjects, aged five and six, and, second, would previously established interactions of OR and sex in relation to learning be manifest at this early age. Third, it was hoped that classification into the three categories of High, Medium and Low Orientors would be more informative than the previously used High and Low. Several investigators (Hebb, 1949, Berlyne, 1960) have suggested that there is a U-shaped relationship between arousal and performance. Considering the OR as indicant of arousal, at least three such groups are required to study this U-shaped relationship. Fourth, in order to bring greater generality to previous findings a relatively new index of the Orienting Response was used, namely, heart rate change. Graham & Clifton (1966) and Chase & Graham (1967) have provided support of the hypothesis that heart rate deceleration is a major component of the OR. Fifth, it was desired to try and establish the relationship of the OR and performance across several different learning tasks that presumably involve different processes, namely,

simple concept learning, discrimination learning and, paired-associates learning.

## Subjects

The Ss were 102 kindergarten children, ages 5 and 6.

## Procedure

Both ECG and beat-to-beat cardiotachometer readings of the heart beat and heart rate were obtained by right arm to left leg electrode placement and use of a Gilson polygraph. E always remained in the same room with the subject, but out of eyesight. Continuous white noise was delivered free-field and the intensity of the noise and polygraph combined was 58 db. Fifteen tones (1000 cps) were delivered freefield at an intensity of 61 db. A sixteenth tone (2000 cps) was delivered at the intensity of 70 db. Tones were presented every 10 seconds (stimulus offset to stimulus onset) and lasted for 5 secs. Resting measures were recorded for three minutes prior to presentation of the tones.

The measure of the OR was obtained using the response to the first tone. It was also hoped that the sixteenth trial would produce an OR because of the change in stimulus frequency and intensity. The measure of the OR was the difference between prestimulus and poststimulus heart rate. Prestimulus level was designated as the slowest heart rate during the three seconds preceding stimulus onset and poststimulus level was designated as the slowest heart rate in the 3 seconds following stimulus onset.

A covariance analysis of the kind recommended by Benjamin (1963) was performed in order to see if it was necessary to adjust heart rate change

scores to take into account the Law of Initial Values.

A distribution of scores, was made up on the basis of subjects' heart rate change ranging from high deceleration through no change through acceleration. The distribution was then divided into thirds and subjects were classified as either a High, Medium, or Low Orientor.

Immediately following the OR testing session, the subject was presented with the learning tasks. 96 subjects received the first two tasks which were pictorial analogues of a verbal discrimination task. Six pairs of stimulus pictures were presented tc the subject one of which was designated as correct. The subject's task was to learn to point to all of the correct pictures to a criterion of one perfect trial. The first problem could also be considered a simple concept learning task since all the items that were designated as correct were instances of the concept class of "animals". The second task could not be solved by the use of a concept mediator, since E arbitrarily designated at random which of the stimuli were correct.

The two picture discrimination tasks were scored on the basis of errors and trials to the criterion of one perfect trial. The third problem was a modified P-A task in which 65 subjects were shown five pairs of pictures serving as the stimului and responses. The subject had to learn which pictures "went together." Each pair was presented for thirty seconds. Immediately after the series of six pairs was presented once, the subject was given the stimulus items and was asked to match them with the response items. The response measure used was the number of correct matchings.

Results

Mean heartrate deceleration of the 96 subjects who participated in the picture discrimination tasks was 3.51 and 2.06, respectively, for Trial 1

and Trial 16. Mean heartrate deceleration for the 65 subjects who received the paired-associates task was 3.95 and 2.15, respectively, for Trial 1 and Trial 16.

The correlation between prestimulus heart rate and heart rate change was computed to test for the operation of the Law of Initial Values on Trial 1 and Trial 16. Since none of these correlations was significant, subsequent analyses were based on unadjusted heart rate change scores.

Analyses Based on Trial 1 OR Classification

The mean number of errors on the paired-associates task is shown in Figure 1 of your handout. A least-squares analysis of variance showed a significant main effect of sex, $p < .005$, males having fewer errors than females. There was also a significant interaction of OR classification and sex, $p < .005$, which is graphed in Figure 1. Subsequent trend tests showed a significant quadratic trend by sex interaction, $p < .001$. For males, the Low OR group gave the least number of errors and the Medium OR group had the greatest number of errors. On the other hand, for females the trend was reversed. Low OR females had the greatest number of errors whereas Medium OR females had the least number of errors.

Although the results of errors on picture discrimination tasks I and II are in the same direction as results on the paired-associates task, as shown in Figure 2 of your handout, there were no significant main effects or interactions shown by analysis of variance. Subsequent tests for trend showed a quadratic trend by sex interaction for errors on task I at the .10 level, and errors on task II at the .09 level. Although this does not reach accepted levels of significance, one's confidence is increased due to similarity of these results and the previous results on the P-A task.

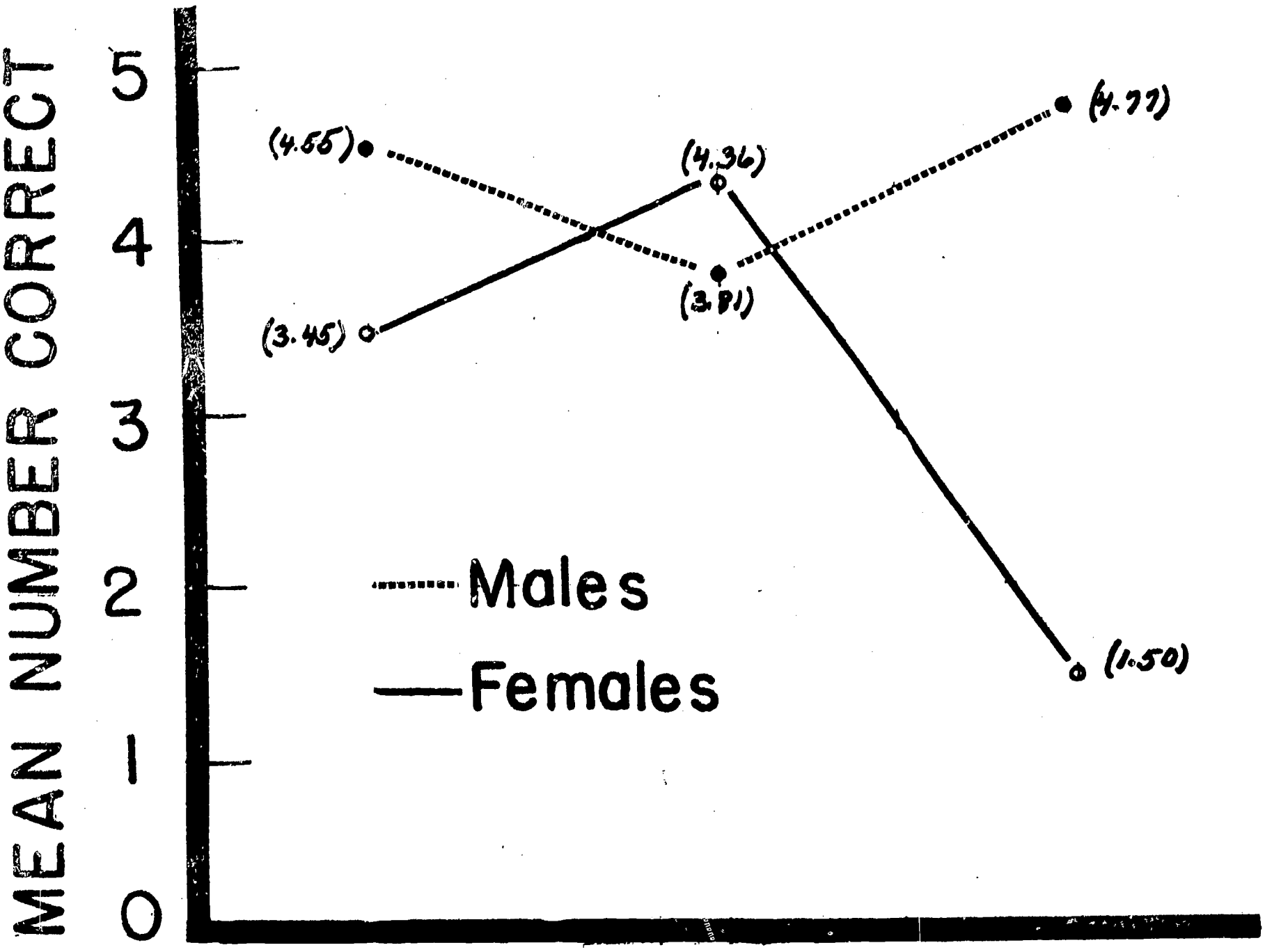


Figure 1. Mean number correct on the paired-associates task as a function of OR classification and sex.

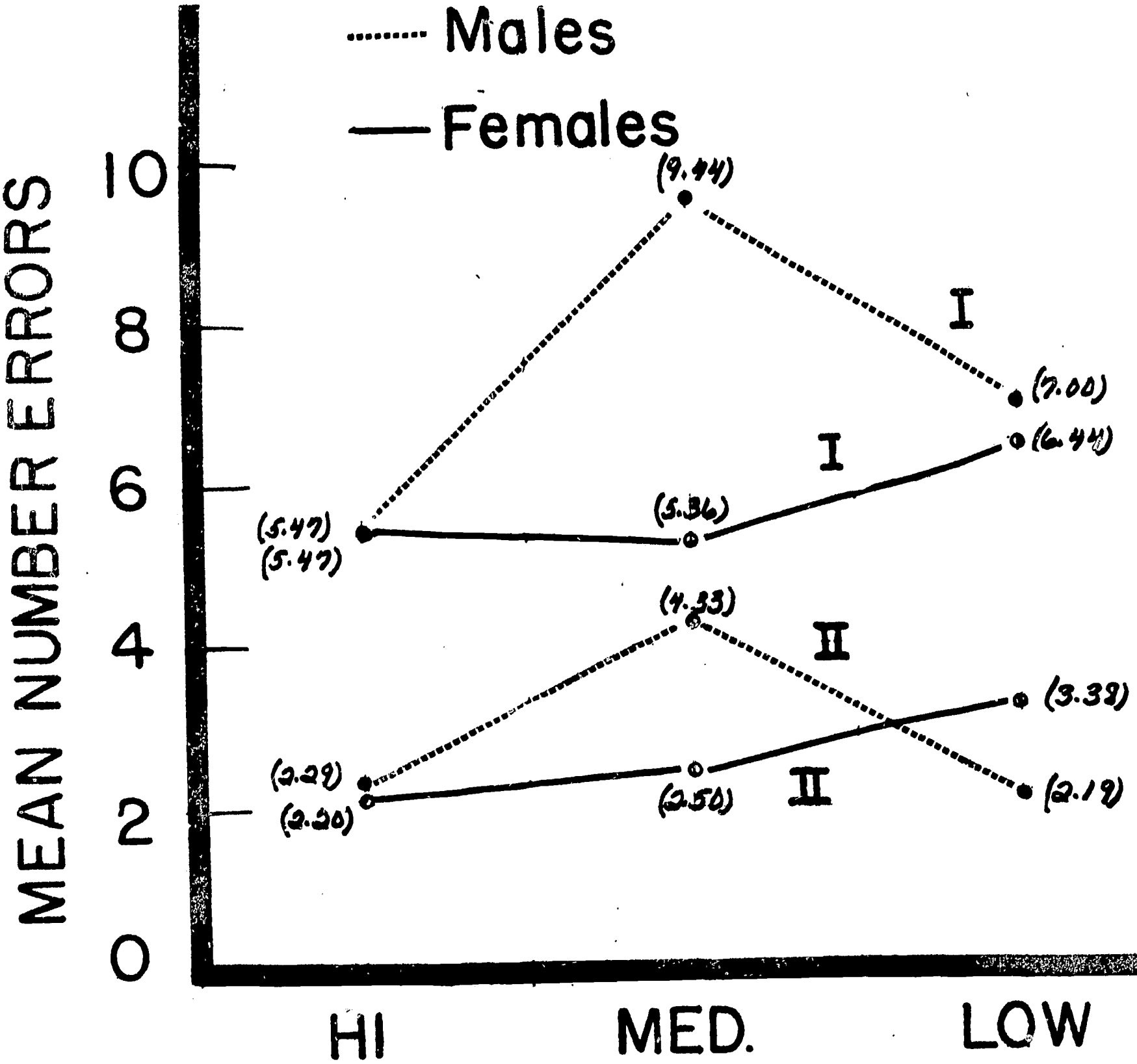


Figure 2. Mean number of errors on picture-discrimination tasks I and II as a function of OR classification and sex.

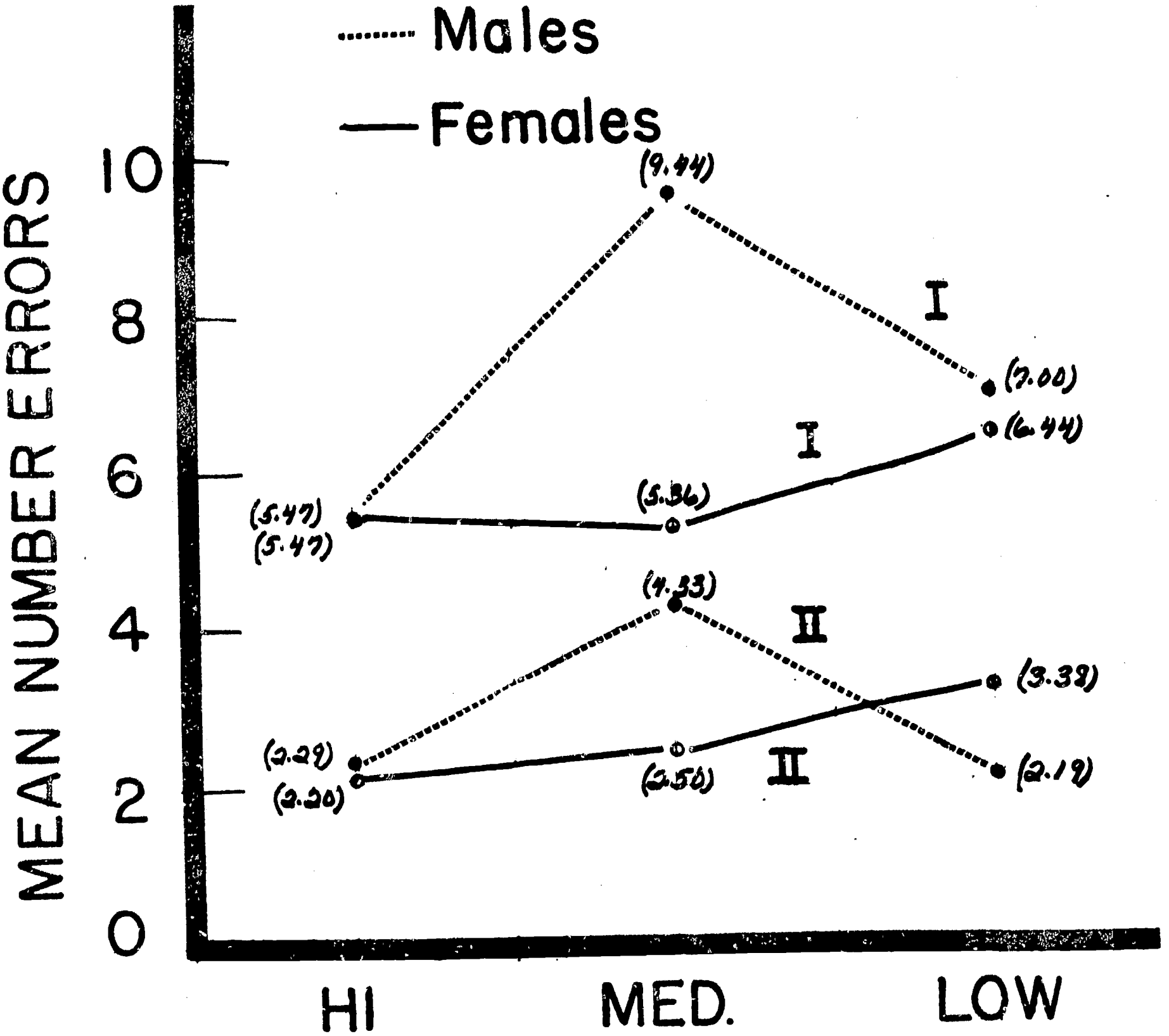


Figure 2. Mean number of errors on picture-discrimination tasks I and II as a function of OR classification and sex.

Analyses Based on Trial 16 OR Classification

A least-squares analysis of variance of the number of errors on the P-A task showed no significant main effect of OR classification or of a significant OR by sex interaction. A subsequent trend analysis showed that the sex by quadratic trend interaction only reached significance at the .10 level. The shape of the trend for males is in the same direction as results based on Trial 1 Classification.

The results for picture discrimination tasks I and I and II showed that neither errors to criterion or trials to criterion showed a significant main effect of OR classification or a significant interaction of OR and sex. A subsequent trend analyses showed only a significant linear trend ($p < .02$) for trials to criterion on picture-discrimination task II. Low orientors required the greatest number of trials and High Orientors required the fewest number of trials.

Discussion

From these results, then, it does appear that there is a relationship between one's classification on the Orienting Response and learning performance on a modified paired-associates task. In addition, sex shows a strong interaction with this relationship. These results do not appear to be consistent with the earlier results of Nies and Belloni who found High Orienting males to be superior in performance to Low Orienting males. With our three categories, High, Medium, and Low as opposed to their High and Low, we found that the trend for males showed optimal performance associated with either a High or Low classification and poorer performance associated with the Medium Orienting category. For females, the trend was reversed as optimal performance was associated with the Medium Orienting category, and the Low

Orienting category is clearly associated with poorest performance. Although the results for females lend some support of the hypothesis that a moderate level of arousal is optimal for performance on the paired-associates task, this conclusion for females was not consistent across the other two tasks. Perhaps the differences in tasks can be conceptualized as differences in memory requirements demanded, the paired-associates task involving the use of short-term memory mechanisms while the picture discrimination tasks, using several trials to reach criterion, involves the use of long-term memory mechanisms. On the other hand, for males, performance trends seem to be consistent across tasks. In general, overall male performance was better than that of females and was quite high. Perhaps some kind of ceiling effect was operating i.e., the task was too easy for males due to cross-sex experimenter-subject relations (a female experimenter ran all of the subjects).

Why sex should be interacting so strongly with orienting classification is a difficult question and one to which we feel we have no adequate answer. The importance of analyzing for sex differences can only be emphasized when future studies of this kind are conducted. All too often the possibility of analyzing for sex interactions is omitted from the design and important information is lost. In sum, it appears that Orienting Response Classification could be an important non-verbal predictor of performance in some learning situations if sex is taken into account. In addition, it is a predictor that presumably could be obtained very early in the organism's lifetime, conceivably in the neo-natal period.

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