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A micro-analytic investigation of reflection-impulsivity in the auditory modality, by Cynthia Lee Bellows

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A MICRO-ANALYTIC INVESTIGATION OF REFLECTION-IMPULSIVITY IN THE AUDITORY MODALITY

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INTRODUCTION

Cognitive Styles

Cognitive style refers to an individual's consistent manner of approaching problem-solving tasks. Various dimensions of cognitive style have been investigated in recent years. Among these are Field dependence-Field independence by Witkin (Witkin, Dyk, & Paterson, 1962); Focusing-Scanning by Bruner (Bruner, Olver, & Greenfield, 1966); Broverman's investigation of Conceptual versus Perceptual Dominance (Broverman, 1960); and the cognitive dimension of Reflection-Impulsivity (Kagan, Rosman, Day, Albert, & Phillips, 1964). These cognitive styles refer to individual differences in processing information which indicate hierarchial preferences with respect to which stimulus characteristics are attended. The present study concerns itself only with the dimension of Reflection-Impulsivity (R-I).

In any problem-solving situation, five phases are involved in the production of a response. These five sequential processes include: 1) Encoding of the problem and task stimuli; 2) Memory of relevant data; 3) Generation of hypotheses upon which to act; 4) Evaluation of these hypotheses with regard to selecting the most appropriate

one; and 5) Final deduction of the correct response. The cognitive dimension of R-I is concerned with the fourth phase: the careful evaluation of generated hypotheses. Not only the appropriateness of the selected hypothesis but also the time involved in evaluating this choice is important in the study of R-I.

Background of R-I

The concept of Reflection-Impulsivity emanated from the research of Kagan and associates who investigated conceptual styles of children and adults. Kagan, Moss, and Sigel (1963) presented three pictures to children in the first through sixth grades. The children were asked to select the two which "go together in some way" and to explain their choice. Younger children based their pairings on functional relationships (e.g., a watch and man go together because the man wears the watch). With increasing age, the children's responses assumed a categorical basis (e.g., a watch and a ruler go together because they are both nonliving things). Finally the older children in the sample most often gave analytic responses - their pairings were based on finding identical component parts within two of the stimuli (e.g., a watch and ruler go together because they both have numbers on them). It was further noted that longer latencies existed between presentations of the pictures and reporting of analytic

responses than reporting of either functional or categorical responses. Functional responses required the least amount of time.

It was hypothesized by Kagan that the analytic response was dependent upon two antecedents; 1) a predilection to reflect over alternative possibilities and 2) a tendency to visually analyze the stimuli as opposed to a style which would involve a more global survey of the pictures. The increased time noted when producing analytic responses was suggested as having resulted from this exaggerated reflection and more careful analysis of the stimuli. It has been theorized by Kagan and associates (Kagan, et al., 1963) that the functional response is the most obvious and thus the first to enter consideration. If the relationship is considered and rejected, the categorical response is then examined. Only after the rejection of these alternatives does the analytic response receive attention. It has been assumed that this hierarchy is generally followed and thus increased latency accompanies production of the analytic response. In subsequent research, Kagan shifted his interest from the investigation of the production of analytic concepts to the study of its major antecedent, reflection, and a new cognitive style came under investigation. This new dimension was termed Reflection-Impulsivity (R-I) (Kagan, et al., 1964).

Theoretical Construct of R-I

Reflection-Impulsivity is concerned with situations in which high response uncertainty exists. Differing performance in such situations is accounted for by the manner in which the individual approaches and subsequently works through a task. When presented with tasks involving high response uncertainty, many responses are at the individual's disposal in working toward a solution. On these tasks in which the most obvious response is generally incorrect, the child must employ perceptual and conceptual rules to select the correct alternative. One strategy is to explore the problem intensely, responding only when the possibility of error is minimized; another is to respond quickly, accepting and acting upon the first hypothesis formed, with little regard for performance. Careful analysis of the task and the consideration of alternative hypotheses before responding results in fewer errors and requires longer response time. Children employing this approach are termed Reflective. Those who fail to consider alternative hypotheses and who act upon their first inclination commit more errors while responding faster. These children are called Impulsive.

Tasks to Measure R-I

Several tasks have been employed to determine which cognitive strategy an individual generally relies on to produce a response.

The Design Recall Test (DRT) (Kagan, et al,. 1964) is a match-to-sample task involving geometric forms. The child is visually presented with a geometric form for five seconds and then the form is removed for 15 seconds. At the end of the imposed delay interval, the child is asked to select the original form from among a group of eight to ten alternatives. All alternatives are similar to the original but only one is identical. Response latency and the number of errors per trial are recorded.

A second task designed to measure R-I is the Haptic-Visual Matching Test (HVM) (Kagan, et al., 1964). The HVM involves the modalities of touch and vision. The subject is presented with a three-dimensional form to be haptically explored. At the end of an unlimited palpation time, the child is visually presented with five line drawings, one of which is an exact schematic of the original three-dimensional form. The subject is asked to find the one drawing which corresponds to that which was felt. Measurements taken are initial palpation time, response latency, and the number of errors committed.

The Matching Familiar Figures Test (MFF) of Kagan, et al., (1964), is by far the most often employed measure of R-I. This is a visual match-to-sample task. On the MFF, the child is presented with a two-dimensional line drawing of a familiar object (the Standard) and six highly similar line drawings (the Alternatives). The

child is asked to find the one alternative which is identical to the standard. The MFF is so designed that the standard is presented simultaneously with two rows of three alternatives each. Alternatives vary from the standard in very minor details, and thus close visual attention is necessary for a correct match. A maximum of six errors per trial is allowed before the child is shown the correct alternative. As with the other tasks, measurements include number of errors and latency to first response.

All of the tasks designed to measure the cognitive dimension of R-I are match-to-sample tests involving a choice among several alternatives and high uncertainty as to which alternative is identical to the standard.

<u>Classification Along R-I</u>

Whether the child is classified as Reflective or Impulsive is a function of two variables: 1) cognitive tempo (latency) and 2) performance (errors). A negative correlation has generally been found between latency and error scores with coefficients ranging between -.40 and -.60. This is true when error and latency scores within the same task are compared as well as when the relationship between error scores on one measure of R-I and latency scores on a different measure is reported (Kagan, 1965a; Kagan, 1966a; Kagan & Kogan, 1970). Therefore, classification

in terms of R-I involves a dual-criteria procedure. Error and latency scores are split at their respective medians. Subjects scoring above the median on latency and below on errors are termed "Reflective". Children below the latency median (short response time) and above in errors are classified as "Impulsive". Generally, 60% to 70% of any sample can be classified as Reflective or Impulsive with a near equal number of subjects in each group. However, the correlation between errors and latency is not perfect and therefore there are some children responding quickly and making few errors while others are slow to respond and make many errors. These children comprise two small extreme groups which are screened out by the dual criteria procedure. Children who respond quickly (below the latency median) and yet commit few errors (below the error median) are termed Fast-Accurates; children above both medians (requiring a long time to answer and still committing many errors) are classified as Slow-Inaccurates. Generally, 15% to 20% of a sample will fall in each of these groups. Only recently have these small extremes been included in statistical analysis.

Generality of R-I

The intertask consistency found between reaction time on one measure of R-I and errors on a second measure

is evidence for the existence of a generalized conceptual style. Further support for the generality of this style comes from research showing that the tendency to be classified as Reflective or as Impulsive is not confined to a single test such as the MFF. Rather, a child's classification is maintained across any task having the singular property of high response uncertainty. Latency scores on the MFF are highly correlated (.60 to .80) with latency scores on the HVM (Kagan, 1965a). In addition, significant correlations have been found between error scores on the MFF and each of the other tasks used to measure R-I (DRT and HVM).

The above tasks employ situations in which all the alternatives are presented to the child. The tendency to reflect or not before responding would assume more meaning as a generalized cognitive style or pattern if it could be shown that the child's classification on the R-I dimension is correlated with performance in situations in which the child generates his own alternatives from which to act. A tachistoscopic recognition task was administered to Reflective and Impulsive children (Kagan, 1965c). The task consisted of six ambiguous, nonsensical pictures (e.g., a bird with a plane fuselage, etc...) which were presented initially for 18 milliseconds with subsequent exposure periods increasing to a maximum

of 3 seconds or until the child correctly identified the pictures. The child was asked to describe and draw exactly what was seen. When second and third graders were administered the task, significant positive correlations were found between recognition threshold, response latency in verbalizing the description, completeness of the drawing and latency scores on the MFF. Lower yet still significant correlations were found between the T-scope task measures and latency scores on the HVM.

A different task requiring the child to provide the alternatives also showed significant correlations with classification on the R-I dimension. In an interview situation, where adults asked fourth and fifth graders questions involving some degree of response uncertainty, Reflective and Impulsive children, as classified by the MFF, responded differently in terms of latency to first response (Kagan, 1965a). As would be expected, Reflective children took longer to respond than did the Impulsives.

Stability

Another characteristic of the R-I style is that classification within the dimension is stable over time. Messer (1970) has provided evidence that, relative to his age-mates, the child's cognitive style will remain stable over at least two and one-half years. In spite of this stability pattern, it has been noted that the

child tends to become more reflective, with age, relative to past performance (Kagan, 1966a; Kagan & Kogan, 1970; Kagan, et al., 1964). Kagan has hypothesized that as the child becomes older, he tends to divide the stimulus into more component parts and analyze each of these in turn. This process of molecular study requires more time and results in a more careful analysis and thus heightened performance. These two variables, increased latency and decreased errors, have the effect of categorizing the child as more reflective. However, if this is true of all the children included in the sample, the medians used in classification will shift (latency median will shift upward and error median will shift downward) and thus any one child's relative position on the dimension will not change.

Sex Differences

Generally, no sex differences have been found on either latency or error measures along the R-I dimension. As a result, classification within any group has a near-equal representation of sex (Kagan, 1965b; Kagan, 1965c; Katz, 1971; McKinney, 1973). Bjorklund and Butter (1973) reported that while latencies on the MFF were similar across sex, males made significantly more errors than did females. Based upon the dual-criterion classification system, however, there were no sex differences noted.

Relationship of R-I to Other Behaviors

Several studies have investigated the relationship between performance on R-I tasks and other behavioral measures. On school related tasks, such as inductive reasoning, it was found that Impulsive children make more errors than do Reflectives (Kagan, Pearson, & Welch, 1966). Kagan (1966b) has shown that Impulsive children report more incorrect words in a serial-recall task than do their Reflective age-mates. In addition, Kagan (1965b) has shown that Impulsive children make more errors of recognition in reading English words presented singularly or in a prose selection. Lesiak (1970) has provided evidence that Reflective children score significantly higher than do Impulsive children on reading comprehension and word tasks. Butler (1972) classified second-grade boys on the basis of the MFF and then tested them on oral reading performance. It was found that Reflective readers made more repetitions and corrected a greater percentage of their total errors than did the Impulsives. Kalash (1973) has investigated the relationship between R-I and reading readiness. First-grade children, who had not yet learned to read, were administered the New York Prereading Assessment. Previously, the children had been classified as either Reflective or Impulsive on the MFF. The reading readiness measure indicated

significant differences between children employing different cognitive styles. Reflective children consistently scored higher on the test than did Impulsives.

Although no significant correlation has been found between verbal ability and the R-I dimension (Harrison and Nadelman, 1972; Kagan, 1965b; Kagan, 1966a; Kagan, et al., 1964; Katz, 1971), failure in school has been shown to be highly correlated with the Impulsive cognitive style (Messer, 1970).

Cognitive Strategies of Reflectives and Impulsives

In view of the fact that Reflective children take longer in responding and score higher than Impulsives on measures other than those used to classify subjects, it must be that different patterns of processing are being employed by children exhibiting different cognitive styles. Investigators have hypothesized that Impulsive children are less adept in the second and third processes involved in problem solving - those involved with evaluating each of the alternatives and a final careful re-evaluation of the chosen alternative. It is suggested that "Impulsives tend to act on their initial hunch without reflection as to the potential accuracy of their choice" (Kagan, et al., 1964).

Siegelman (1969) investigated the search strategies employed by both Reflective and Impulsive children classified on the MFF. Rather than presenting the

standard and six alternatives simultaneously as was done in the past, Siegelman presented the child with blurred images of the original MFF stimuli which could be brought into focus only by depressing a button beneath the picture. Siegelman analyzed which pictures the child attended to, how many times he attended to each, the duration of his attention, and the order in which the pictures were attended to.

Siegelman found that Reflective and Impulsive children differ on many indices of attention deployment. Absolute measures, which compare Reflectives and Impulsives on total number of looks toward any or all of the alternatives, supported the hypothesis that Reflective children spend more time deploying attention to the task as a whole and to its component stimuli. By converting absolute measures to percentages, Siegelman ascertained that Reflective children deploy a greater percentage of their time toward the alternatives than do Impulsive children. However, Impulsives look at the standard and chosen alternative much longer and more often, relative to their total looking time, than do Reflectives. Beyond this, Impulsive children ignored two-and-one-half times as many alternatives as did their Reflective age-mates (2.83 versus 1.11).

It seems that Impulsive children are greatly biased in their attention deployment, at least more so than are

Reflectives. Impulsive children employ a much more haphazard and less inclusive search pattern than do Reflectives and thus respond faster and commit more errors. Siegelman hypothesized that the two groups actually differ in the way they assess the entire situation before them. She theorized that Reflective children search for differences between two alternatives and then return to the standard for confirmation as to which of the two is less correct. This alternative is then eliminated from further consideration and another alternative is brought into the comparison method. This process proceeds until all alternatives but one have been eliminated and only then is the response given. On the other hand, Impulsive children seem to make direct comparisons between the standard and one alternative at a time while looking for differences between the two. If a difference is found, the alternative is rejected and another is contrasted with the standard. If no difference is found, the alternative is declared as the "same". Because the MFF and other measures of the R-I dimension are tasks which involve small differences between correct and incorrect alternatives, the Impulsive child's inefficient search strategy would obviously lead to more errors. It was therefore suggested to examine more closely the search strategies employed by children.

Nelson (1968) incorporated the findings of Siegelman into a modification program intended to bring Impulsive children closer to the performance of Reflectives. He attempted to modify the Impulsive's style by training them to employ the search strategy proposed by Siegelman. The children were taught to look at two alternatives and then return to the standard for confirmation as to which of the two was correct. Nelson stressed to the children the necessity of looking at all the alternatives before a decision was made. On a post-training test, it was found that previously classified Impulsive children now observed a greater number of alternatives, made more observations of these alternatives, and followed a more systematic approach to scanning the stimuli. These strategy changes increased the probability of a correct response and therefore error scores of the Impulsive children more closely resembled those of the Reflectives. Because more comparisons were being made, the Impulsives increased their latency scores. The modification program was a success in view of the resulting decrease in errors and increase in latency.

Drake (1970) designed a study to determine whether latency differences between Reflectives and Impulsives could account for differing cognitive approaches toward solving the MFF and whether this classification difference would maintain itself across age. She administered the MFF

to third graders and college undergraduates while taking eye fixation measures of the standard and alternatives. It was assumed that eye fixation reflected the person's cognitive approach to the task. Nelson (1968) and Siegelman (1969) reported that Reflective and Impulsive children within the same age group employed different strategies all through the test. Others held the theory that Reflective children perform similarly to Impulsives in searching for the correct alternative but that Reflectives repeat the process more often before responding. This repetition requires longer time and assures better performance. However, Drake reported that Reflective subjects of all ages employed strategies which allowed them to gain more perceptual information than did their Impulsive age-mates. Further, it was found that the processes employed by the subjects became more efficient and relevant as age increased. Adults displayed a more detailed analysis of the stimuli and their elements while children, in comparison, looked at and compared more global stimulus aspects. This finding could explain the earlier reports that the tendency toward Reflectivity increases with age. Furthermore, both the Reflective and Impulsive adults were found to observe more alternatives per trial than the Reflective children. Of the four groups observed (Reflective adults, Impulsive adults, Reflective children, and Impulsive children) the closest

comparison in search strategies could be made between Reflective children and Impulsive adults. Even though differences were found, due to age, qualitative similarities were seen. Both groups employed the strategy of finding differences between the standard and variants even though the directions to the task were to find the alternative which was the same. These two groups gave a disproportionate amount of time and looks to the standard at the beginning of each trial which neither the Impulsive children nor Reflective adults had done. The Reflective adults offered more time to observing the alternatives in order to find differences between them and employing the standard only as a check when contrasts were found. Drake's is the first study which attempts to establish some developmental pattern in search strategy. Much can be gained by analyzing differences across ages in determining what aspects of the child's cognitive development appear as important elements in conceptual styles such as the R-I dimension.

Generalization of R-I Across Modalities

When investigating a dimension as broad as R-I, many different avenues of search can be taken. Butter (1971) devised the Haptic Matching Task (HMT) in order to assess R-I in the haptic modality. The HMT is a task involving 10-sided random forms rather than pictures as in the visual MFF. Third and fourth grade boys were presented

with a standard form and five alternatives, only one of which was identical to the standard. Forms were presented haptically behind a black opaque curtain so that vision was totally obscurred. As on other tasks measuring R-I, the number of errors committed and latency to first response were recorded. Butter also recorded palpation time and number of observations of the standard and each alternative. In addition, each child was administered the visual MFF so that the cross-modal generality of R-I could be assessed. Butter found high significant correlations between latency and errors on the HMT ($r = -.72$). Furthermore, the correlations of .64 for latency on MFF and HMT and of .66 for errors on the two tasks attest to the cross modal generality of the R-I dimension. In addition, 58% of the initial sample maintained classification across the two measures. That is, Reflectives on the MFF were Reflective on the HMT and Impulsives on the MFF were Impulsive on the HMT. The remaining subjects were either Reflective or Impulsive on one task and unclassifiable on the other (Fast-Accurate or Slow-Inaccurate). Further, only 5% of the original sample, who were classified as Reflective or Impulsive on the MFF were later classified as the opposite extreme on the HMT (Reflectives becoming Impulsive and Impulsives becoming Reflective). Butter also investigated the search strategies of children employing different cognitive styles. He found that

Reflective children made more total observations of the standard and alternatives on the HMT than did the Impulsives, and these palpations were of a longer duration. Impulsives ignored two-and-one-half times as many alternatives as did the Reflectives. Therefore, as Siegelman (1969) and Nelson (1968) reported for a visual task (MFF), Impulsive children are also greatly biased in their attention deployment on a haptic task.

Butter also attempted to modify an Impulsive disposition by teaching a Reflective scanning strategy. Subjects, who were classified as Impulsive in both modalities, were trained to find differences between two alternatives and then return to the standard for confirmation. Three groups were formed from the original sample of Impulsive children: 1) subjects trained in the haptic modality; 2) subjects trained in the visual modality; and 3) a control group which received no training. The first group, those trained in the haptic modality, became Reflective on the second administration of the HMT and maintained that Reflectivity on the MFF posttest. However, those children trained with the Reflective style in the visual modality became more Reflective on the MFF, but showed no change from their initial performance on the HMT. The Control group did not change on either posttest.

The importance of Butter's investigation for this research is the finding that R-I is a cognitive dimension with a global base and is not completely visually bound. Reflection and Impulsivity appear to be general dispositions or attitudes in approaching problem-solving tasks having high response uncertainty.

THE PRESENT STUDY

The present study is concerned with measuring Reflection-Impulsivity in the auditory modality. More specifically, the research investigated search strategies of Reflective and Impulsive children when presented with an auditory match-to-sample task of high response uncertainty. Butter (1971) supported the hypothesis that R-I is a generalized cognitive pattern rather than modality specific. This investigator attempted to extend this conclusion by testing the generality of R-I across another modality - audition.

The auditory modality was chosen because current literature has found significant positive correlations between reading performance and auditory discrimination ability (Buktenica, 1971; Bruininks, 1969; Dykstra, 1966; Morency, 1968; Oakland; 1969). In view of these correlations and those found between Impulsivity and reading problems (Butler, 1972; Kagan, 1965b; Kalash, 1973; Lesiak, 1970), it seemed worthwhile to combine the two approaches and investigate R-I in the auditory modality.

Four hypotheses were established at the outset of the research. The first was that R-I can be meaningfully

measured in the auditory modality. It was expected that a significant negative correlation would exist between error and latency to first response on the Auditory Impulsivity Task, a match-to-sample task in the auditory modality. A second hypothesis was that children maintain their classification as Reflective or Impulsive in terms of errors and latency across the modalities of vision and audition. The third hypothesis stated that children, classified as Reflective and Impulsive on the established MFF visual task, and are known to employ different scanning strategies, also employ different scanning strategies on the auditory task. The measures for analyzing the scanning strategies are listed below. The last hypothesis was that children within a classification, that is Reflective or Impulsive, maintain the same scanning strategy across the modalities of vision and audition.

The following measures were recorded on both the visual MFF and the auditory AIT in order to test the above hypotheses:

Classification Measures:

(1) total number of errors committed (E)
(2) latency to first response (L)

Strategy Measures:

(3) number of observations of the Standard ($\underline{O}_S$)
(4) number of observations of the Alternatives which were not chosen on the first response ($\underline{O}_{\bar{C}}$)

(5) number of observations of the Alternative which was chosen on first response ($\underline{O}_c$)
(6) number of Alternatives observed ($\underline{A}_o$)
(7) number of observations of the most frequently observed Alternative ($\underline{O}_f$).

All of the above measures were taken to first response only. If measurements are taken beyond this point, there would be differential loss of scores because Reflective children commit less errors than do Impulsive children.

METHOD

Subjects

Eighty-one children (45 males and 36 females) were included in the final sample. A total of 7 children were excluded from the analyses because of incomplete data. Only fourth graders were seen in the testing sessions so that results could be viewed in relation to Siegelman (1969) and Butter (1971). Subjects were chosen from two southern Ohio cities of comparable social and economic status. The mean age of the final sample was 10-years-1-month with a range of 9-years-1-month to 10-years-8-months. IQ scores were not available and therefore no sample description of this measure can be given. However, school officials indicated that the children were of normal intelligence with no one exhibiting any extreme scores.

Instruments and Apparatus

Three tests were administered: the Wepman Auditory Discrimination Test (Wepman, 1958); the Matching Familiar Figures Sequential Presentation Task; and the Auditory Impulsivity Task.

Wepman Auditory Discrimination Test

The Wepman Auditory Discrimination Test was individually administered for purposes of screening children with auditory deficiencies. The test consists of 40 three- to six-letter word pairs of the consonant-vowel-consonant format. Thirty pairs of words differ slightly in that the vowel sound is the same but the beginning or ending consonants vary (e.g., sheath - sheaf) or the releasing or arresting consonants are the same and the vowel differs (e.g., pen - pin). The remaining ten pairs of words are identical. The words in each pair are matched for familiarity, length, and membership in the same phonetic category. The child's task was to listen to the word pairs and respond as to whether they are the same or different. A series of practice trials precedes the test so that the experimenter can ascertain whether the child fully understands the meaning of the words "same" and "different". In those cases where the child does not understand, instructions are repeated to ensure that each child is at the same level of understanding when testing begins.

Wepman suggests that a child committing more than 15 false-positive (saying "same" when actually different) or three false-negative (saying "different" when actually same) errors may have a hearing defect. This criterion

of performance was used in the present study for screening purposes.

The entire task was tape recorded to control for possible experimenter word errors in the recitation of the test, and also for standardization across subjects. Special care was taken to recite the words without emphasizing particular parts and to maintain constant time between words within a pair and between word pairs.

The Matching Familiar Figures Sequential Presentation Task (MFF-SPT)

The MFF-SPT is a visual match-to-sample test similar to that devised by Kagan, et al., (1964). Kagan's Matching Familiar Figures Test (MFF) contains two practice and 12 test trials. The stimulus items consist of sets of black and white line drawings of familiar objects (boat, teddy bear, tree, etc...) set up such that a single drawing (the Standard) is presented simultaneously above two rows of three drawings each (the Alternatives). The subject is to choose the one alternative which is identical to the standard. The alternatives differ from the standard in very minor detail and thus close visual analysis is necessary for a correct match. On each trial the subject's latency to first response and the number of errors committed are recorded. A maximum of six errors per trial is possible before the child is informed of the correct match.

The MFF-SPT differs from the original MFF in that the seven pictures (the Standard and six Alternatives) are not visible at the same time. Rather, only one picture may be viewed at a time and the image of this picture must be retained for comparison to the standard or other alternatives. The child is presented with a stimulus panel consisting of seven doors which slide left to right. The doors are arranged in three rows with the standard centered above two rows of three alternatives. When the door is opened, a line drawing is exposed. The line drawings used in the MFF-SPT are those of the MFF. The child is told that there are pictures behind the doors and that he will be able to see them by sliding the doors open. Further, the subject is told that his task is to find the one picture behind the doors at the bottom (the experimenter points to the doors housing the Alternatives) which is exactly the same as the picture behind the one door at the top (the experimenter points to the Standard). Each child is instructed to open only one door at a time and that the door must be closed completely before another may be opened. Also, the child is told that he may look at any picture, as many times as wanted, and in any order desired. When the child finds the picture which is exactly the same as the one at the top, he is to tell the experimenter by pointing to the door. Once the

child has announced his choice, the experimenter 1) records the response; 2) tells the child whether he is right or wrong; and 3) records the latency to first response. In the event that the child is incorrect, he is told that the picture chosen is not exactly the same and that he should look again for the one which is identical to the picture at the top. If the child does not find the correct match after six tries, he is then shown which picture is the same. The experimenter records the total number of errors per trial in addition to latency.

The stimulus panel which houses the doors and pictures is made of 1/8" Testalite and measures 30" x 21". The doors are 4½" square, with a 3/4" knob protruding in order to slide the door open. Distance between pictures within a row is 4½"; distance between rows measures 2½". The 14 stimulus cards which contain the pictures (two practice and twelve test trials) are stored behind the stimulus panel. When a trial is completed, a 23½" x 4" hinged panel is opened and the stimulus card removed thus allowing the next card to come into position behind the closed doors. Stimulus cards are loaded against a spring action board, behind the panel, which allows each card to rise into position in succession. The entire apparatus is contained in a 30" x 21" x 6" plywood case for transportation to the schools.

Micro-switches are attached to the backside of the panel and to an Esterline-Angus 8-Pen Minigraph Recorder such that a $\frac{1}{4}$" displacement of a door activates the recording pen. Seven of the eight pens are attached to the standard and six alternatives. The eighth pen is attached to a remote control push button, operated by the experimenter, to record the latency to first response.

<u>The Auditory Impulsivity Task (AIT)</u>

The AIT, devised for this study, is a match-to-sample task in the auditory modality. The task is patterned after the visual MFF and consists of two practice and ten test trials. Subjects are presented with an 11" square, sloping panel consisting of five buttons: one at the top (the Standard) and two rows of two buttons each (the Alternatives) positioned below. When any of the buttons are depressed, a sequence of tones interspersed with pauses is heard. The child is told that when he pushes a button, he will hear some musical notes with spaces between them. He is further told that only one of the four buttons at the bottom (the experimenter points to the alternatives) will play the exact same pattern or group of notes and spaces that the one at the top plays (the experimenter points to the Standard). It is explained to the child that his task is to find the one button at the bottom which is the same as the top button. The child is allowed to push any button,

as many times as he desires, and in any order he wants. The only restraint put on the subject is that only one button may be pushed at a time and that he must allow the entire sequence to play through before another button may be pushed. In the event the child releases the button before the entire sequence is played, the AIT apparatus will complete the sequence. The subject is told to indicate to the experimenter which button he thinks is identical to the standard by pointing to his choice and saying, "This one". When the child makes his response, the experimenter 1) records the response; 2) gives the child feedback as to whether he was correct or not; and 3) records the latency to first response. In the event the child makes an incorrect response, he is told that the two buttons are not exactly the same and to try to find the one which has no difference from the one at the top. The child is allowed to commit four errors per trial before the correct response is shown to him. The two practice trials are incorporated into the test in order to acclimate the child to wearing earphones and to indicate whether the subject understands the task. The instructions given prior to the AIT are found in Appendix A.

The operation of the AIT apparatus is based on a card reader scanning a computer card which contains the pre-punched stimulus sequences. If, while scanning a

column of the card, the card reader finds a hole punched, an oscillator is stimulated and generates a tone. If the card reader scans the column and no hole is punched, the oscillator is not stimulated and therefore a pause results. Holes are punched in the column in relation to the pattern of tones and pauses desired. Each group of five consecutive columns of the computer card corresponds to one trial. Each column, within the group is represented by a separate button on the stimulus panel. A Trial Select dial on the apparatus enables the experimenter to determine which series of columns the card reader will scan.

The number of tones per button has a range of four to seven, with pauses between tones ranging from one to three. The tones are of $\frac{1}{2}$-second duration with a frequency of 400Hz on the sine wave. The temporal pause between two tones is also of $\frac{1}{2}$-second duration. Thus, the shortest sequence involves a total listening time of $2\frac{1}{2}$-seconds and the longest requires the child to attend for 5-seconds. The trials are randomly ordered in terms of difficulty and the position of the correct alternative is random with the stipulation that the correct match occupies the same position three times (2 practice and 10 test trials). A pictorial representation of the AIT stimulus sequences is presented in Table I.

TABLE 1

A Visual Representation of the AIT

(Dots imply musical tones, spaces imply temporal pauses)

	STANDARD	ALTERNATIVES 1	2	3	4
P1	•• •	•• ••	••••	<u>•• •</u>	• ••
P2	• • •	•• ••	<u>• • •</u>	•• • •	• ••••
1	• •• •••	<u>• •• •••</u>	•• •	•• ••• •	• ••• •
2	• •••	••• •	• • •	•• ••	<u>• •••</u>
3	•• •• ••	•• • •••	••• • ••	<u>•• •• ••</u>	•• • ••
4	• • • •••	• • ••• •	• ••• • •	• • • ••	<u>• • • •••</u>
5	•• • • •••	•• • •• ••	<u>•• • • •••</u>	•• •• • •	•• •• •••
6	•• •••	<u>•• •••</u>	• • •••	••• ••	• ••••
7	• •• •	•• • •	• • ••	<u>• •• •</u>	• • •
8	••• • •	• ••• •	•• • ••	• • •••	<u>••• • •</u>
9	•• • ••• •	<u>•• • •• •</u>	• •• • ••	•• • • ••	• • •• ••
10	•••• •••	••• ••••	<u>•••• •••</u>	••• •• ••	••• ••• •

Note: The correct match-to-standard is underlined.

An Esterline-Angus Mini-Event Recorder is attached to micro-switches below each of the buttons to record the child's observing responses. Records are obtained as to which buttons are depressed, how many times each button is depressed and the total time (in seconds) before a response is given.

The AIT is not identical to the MFF in that only 4 alternatives are presented rather than 6. However, pilot testing indicated that when the child was presented with a standard and six alternatives, there was extreme confusion in remembering which button played which sequence. Even the most careful child made many errors and gave up easily because the task was too difficult. With 4 alternatives, differences were seen between children employing careful attention and those who were very quick to respond.

Also, the AIT consists of only 10 trials rather than 12 as in the MFF. This is because pilot testing indicated that children became tired and this fatigue became a more compelling variable than was strategy. Up to ten trials, the children would maintain a search strategy (some were careful while others were not) but after this point, search became random and it became obvious that the child was no longer attending to the task.

PROCEDURE

The study was conducted in two sessions. Forty-one children were administered the Wepman Auditory Discrimination Test followed immediately by the MFF-SPT during the first session. These children received the AIT alone during the second session. The remaining 39 children received the Wepman Auditory Discrimination Test and the AIT within the first session and only the MFF-SPT during the second. Each session averaged about 25 minutes and all children were seen for the second time within 10 days of their first session. Because two different schools were included in the sample, an effort was made to counterbalance the order of the tests within the schools. However, due to circumstances beyond control, this counterbalancing was not possible, and so the order of tests was counterbalanced across schools only.

The experimenter was introduced by the teacher to the children participating in the study. It was explained to the children that they would be taken into a different room, one at a time, to play some games with the experimenter. The importance of not telling anyone what the games were all about was stressed to the group at the

beginning and to the children individually at the close of each session. For each of the sessions, children were taken to a small, private room provided by the school for testing. After a short period of adjusting to the room and to the experimenter, the testing was begun. The private room was used to exclude any possibility of visual distraction and earphones were provided on both the Wepman Auditory Discrimination Test and the AIT.

All variables were scored prior to classification of children so that the experimenter had no knowledge of whether the child was Reflective or Impulsive when search strategies were coded.

RESULTS

R-I in the Auditory Modality

To investigate the first hypothesis that R-I can be meaningfully measured in the auditory modality, it was necessary to show that errors and latency on the AIT are significantly correlated. A stronger case for the meaningfulness of the measurement can be made if performance in the visual modality (MFF-SPT) could be shown to be related to performance in the auditory modality (AIT). Thus, a correlational analysis was performed on error and latency scores for both the MFF-SPT and AIT.

First, the intra-task correlation was assessed and it was found that a significant correlation of -.32 existed between error and latency scores on the AIT ($p < .05$). A higher correlation of -.68 was found between these same variables on the MFF-SPT ($p < .01$). Significant correlations were also found for similar measures across tasks. AIT and MFF-SPT errors correlated significantly as was the case for latency scores between the two tasks. Further, error and latency scores across tasks were found to be significantly correlated. Table 2 presents the intercorrelations and resulting probabilities.

TABLE 2

Intercorrelations Between Error and Latency Measures on the MFF-SPT and AIT

		MFF-SPT		AIT	
		Errors	Latency	Errors	Latency
MFF-SPT	Errors	—	-.68**	.42**	-.43**
	Latency	-.68**	—	-.33*	.47**
AIT	Errors	.42**	-.33*	—	-.32*
	Latency	-.43**	.47**	-.32*	—

*$p < .05$

**$p < .01$

To combine these correlations into one measure which would assess the overall relationship between performance on the AIT and MFF-SPT, a canonical correlation was performed on error and latency scores of the two measures. This correlation was .42. The test of significance of the canonical correlation resulted in a Chi Square of 16.30 with 4 degrees of freedom and was significant ($p < .01$).

Classification of Subjects

To assess whether R-I generalizes across modalities, it was first necessary to classify subjects as Reflective or Impulsive. The procedure used to classify subjects was to split error and latency scores at their respective medians and to group children as to whether their scores on each variable fell above or below those medians. On the MFF-SPT, children below the error median (less than 8 total errors) and above the latency median (greater than 34 seconds average latency) were classified as Reflective; children at or above the error median (equal to or greater than 8 total errors) and at or below the latency median (less than or equal to 34 seconds average latency) were classified as Impulsive. Children scoring below both medians were classified as Fast-Accurate, and those above both medians as Slow-Inaccurate. Using this procedure, 35 subjects (43.2%) were classified as

Reflective; 31 (38.3%) as Impulsive; 8 (9.9%) as Fast-Accurate; and 7 (8.6%) as Slow-Inaccurate.

Children were classified on the AIT in a like manner. Error and latency scores were split at their respective medians (5 total errors and 50 seconds average latency). This split resulted in the classification of 27 Reflectives (33.3%), 28 Impulsives (34.6%), 12 Fast-Accurates (12.0%), and 14 Slow-Inaccurates (17.3%).

Maintaining Classification Across Modality

A high percentage of subjects maintaining classification across tasks is indicative that the R-I dimension generalizes across modalities. Forty-five of the 81 children included in the sample maintained their classification across the MFF-SPT and AIT, while only 8 of the 81 subjects were classified as Reflective on one task and Impulsive on the other. A nonparametric sign test performed on this data was significant ($z = 4.95$, $p < .01$). This indicated that the difference between the number of children who maintained classification across tasks and those who changed from Reflection to Impulsivity across tasks is not due to chance. Thus, while 55% of the sample maintained classification across modalities, less than 10% of the children crossed both the error and latency medians from Reflection to Impulsivity or Impulsivity to Reflection. The remaining 32% were

either classified as Reflective or Impulsive on one task and scored in the extreme groups, Fast-Accurate or Slow-Inaccurate, on the other task.

<u>Reflective versus Impulsive Scanning Strategies Within Tasks</u>

The third hypothesis, that Reflective and Impulsive children would employ different scanning strategies on both the MFF-SPT and AIT, was tested by performing a Multivariate Analysis of Variance (MANOVA) between cognitive style groups within each task. The MANOVA's were accomplished by means of the MANOVAC computer program prepared by Jeremy D. Finn (1968). This analysis was performed on each of the micro-measures initially stated to be components of the scanning strategy. The micro-measures which were recorded and then included in the MANOVA are 1) number of observations of the standard ($\underline{O}_s$); 2) number of observations of the alternatives which were not selected as a match to the standard ($\underline{O}_{\bar{c}}$); 3) number of observations of the alternative which was selected as a match to the standard ($\underline{O}_{\bar{c}}$); 4) number of different alternatives observed ($\underline{A}_o$); and 5) number of observations made of the most frequently observed alternative ($\underline{O}_f$).

In order to reduce the variance of latency data on both tests, antilog transformations were performed before the MANOVA was applied. Further, on all MANOVA's children were classified on the basis of the MFF-SPT only. To investigate Hypothesis 3, that differences

between Reflectives and Impulsives would be maintained across modality, it was necessary to classify children on the basis of one test only and to retain that classification on the second test. If MFF-SPT Reflectives and Impulsives were contrasted on the visual test and AIT Reflectives and Impulsives contrasted on the auditory task, nothing could be concluded about cross-modal generality of differences between the two groups because the children comprising these groups would be different from one test to the other. However, by classifying children as Reflective or Impulsive on one test and comparing their search strategies in the visual modality and then comparing the search strategies of these same children in the auditory modality, cross-modal generality of differences could be examined. It was necessary to classify on one test only to evaluate Hypothesis 4 also. Hypothesis 4 is concerned with testing the cross-modal consistency of search strategies within groups. A within subjects analysis was required so that any differences which might be found can be attributed to modality effects only and not to the fact that different children's strategies were being employed. It is possible for two children to commit few errors and respond with long latency on the MFF-SPT and AIT but yet employ very different scanning strategies. This research was interested in determining whether children will maintain their same

strategy across tasks, not whether Reflectives in the visual modality employ the same strategy as Reflectives in the auditory modality.

Therefore, for both Hypotheses 3 and 4, the MFF-SPT was selected as the test upon which children would be classified. The MFF-SPT, a sequential presentation of the original MFF, was selected rather than the AIT because it closely resembles the MFF which has been the standard established measure of R-I for several years, whereas this research effort was the first to employ AIT.

Initially, children above the median in errors on the MFF-SPT (Impulsives and Slow-Inaccurates) were compared to children committing fewer errors than the median (Reflectives and Fast-Accurates). The main effect of errors on the MFF-SPT was significant, multivariate $\underline{F}(10, 68) = 8.63$, $\underline{p} < .01$). Furthermore, the two groups (high versus low MFF-SPT errors) were significantly different on every micro-analytic measure recorded from the MFF-SPT and AIT. On both tests, children scoring below the MFF-SPT error median made more observations to the standard, unchosen alternatives, chosen alternative, most frequently observed alternative, and observed more different alternatives than did children scoring above the error median. Means, $\underline{F}$-ratios and resulting probabilities for the differences between these two groups are presented in Table 3.

TABLE 3

Differences Within the Two Modalities

Between Children Committing Low and

High Errors on the MFF-SPT

Test	Low Error Means	High Error Means	Univariate F^a
MFF-SPT			
O_s	41.67	22.47	65.51**
$O_{\bar{c}}$	49.47	23.97	48.59**
O_c	26.35	17.16	45.36**
A_o	49.09	33.05	38.72**
O_f	28.81	18.32	56.22**
AIT			
O_s	23.16	14.79	23.26**
$O_{\bar{c}}$	21.70	15.34	7.92**
O_c	14.56	11.61	16.71**
A_o	27.23	23.66	4.20*
O_f	15.84	12.13	19.33**

Note: Multivariate $F(10, 68) = 8.63$**
a $df = 1,77$

*$p < .05$
**$p < .01$

O_s Number of observations of the Standard
$O_{\bar{c}}$ Number of observations of Alternatives not chosen
O_c Number of observations of the Alternative chosen
A_o Number of different Alternatives observed
O_f Number of observations of the most frequently observed Alternative

A second aspect of this analysis compared children requiring long latencies to respond on the MFF-SPT (Reflectives and Slow-Inaccurates) to children answering quickly (Impulsives and Fast-Accurates). The main effect of latency was significant on the MFF-SPT, (Multivariate F $(10, 68) = 3.35$, $p < .01$). Beyond this, children who took a long time to respond made more observations of every micro-measure of the MFF-SPT than did short latency subjects ($p < .01$). Although the same trend was found on the AIT for long and short latency children for most of the measures (O_s, $O_{\bar{c}}$, O_c, and O_f)($p < .03$), there were no differences found between the groups on A_o, the number of different alternatives observed ($p > .05$). Table 4 presents the means, F-ratios and resulting probabilities for the effects of latency.

Subsequent F-ratios were computed to analyze differences on each of the micro-measures between Reflectives and Impulsives only, as classified on the MFF-SPT. On the MFF-SPT, Reflectives made significantly more observations of O_s, $O_{\bar{c}}$, O_c, A_o, and O_f ($p < .01$) than did the Impulsives. Differences between these groups were also highly significant on the AIT ($p < .01$). The number of alternatives observed, A_o, however, did not differentiate as greatly ($p < .03$) between the Reflectives and Impulsives. See Table 5.

TABLE 4

Differences Within the Two Modalities Between

Children Employing Long and Short

Latency on the MFF-SPT

Test	Long Latency Means	Short Latency Means	Univariate F^a
MFF-SPT			
O_s	42.24	22.36	18.01**
$O_{\bar{c}}$	51.90	22.00	23.93**
O_c	26.60	17.13	12.15**
A_o	50.90	31.51	21.66**
O_f	29.12	18.26	15.41**
AIT			
O_s	23.26	14.90	5.30*
$O_{\bar{c}}$	22.50	14.64	4.86*
O_c	14.74	11.49	6.19**
A_o	27.38	23.59	1.30
O_f	16.05	12.00	6.91**

Note: Multivariate $F(10, 68) = 3.28$**

a *df* = 1,77

*$p < .03$

**$p < .01$

TABLE 5

Differences Within the Two Modalities Between

Children Classified as Reflective and

Impulsive on the MFF-SPT

Test	Reflective Means	Impulsive Means	Univariate F[a]
MFF-SPT			
$\underline{O}_s$	44.23	20.26	83.40**
$\underline{O}_{\bar{s}}$	54.66	20.77	70.54**
$\underline{O}_c$	27.80	16.39	57.45**
$\underline{A}_o$	52.34	30.65	58.08**
$\underline{O}_f$	30.51	17.45	71.53**
AIT			
$\underline{O}_s$	24.03	13.74	28.56**
$\underline{O}_{\bar{s}}$	23.00	14.29	12.18**
$\underline{O}_c$	14.97	11.16	22.67**
$\underline{A}_o$	27.69	23.16	5.49*
$\underline{O}_f$	16.38	11.61	26.01**

Note: Multivariate F (10, 68) = 11.37**
a df = 1,77

*p < .03
**p < .01

Scanning Strategy Consistency Across Tasks

Scanning strategies across tasks were analyzed by means of another Multivariate Analysis of Variance. The question asked was whether subjects employ the same scanning strategies in the modalities of vision and audition. Because the MFF-SPT and AIT had different numbers of trials and the number of doors on the MFF-SPT did not equal the number of buttons on the AIT, transformations had to be made on all data before scanning strategies could be compared across tasks. These transformations were accomplished by dividing the total number of observations of each item ($\underline{O}_s$, $\underline{O}_{\bar{c}}$, $\underline{O}_c$, $\underline{A}_o$, $\underline{O}_f$) by the number of trials included in the test and also by the number of doors (MFF-SPT) or buttons (AIT) accessible. MFF-SPT data was divided by 84 (12 trials and 7 doors); AIT data was divided by 50 (10 trials and 5 buttons)

Difference scores between similar measures across the two modalities were computed from the resulting transformed data for each micro-measure of scanning strategies. This was accomplished by subtracting AIT from MFF-SPT data and testing the resulting difference against zero. Initially, difference scores were tested for all children in the sample. No differences were found between the two modalities for the measures $\underline{O}_s$, $\underline{O}_c$, $\underline{O}_f$, and $\underline{A}_o$. However, there were significant differences between

the MFF-SPT and AIT in the number of observations made of those alternatives not chosen as a match-to-standard ($O_{\bar{c}}$)($p < .01$). These data indicate that, overall, children maintain similar scanning strategies across modalities of vision and audition. Means, F-ratios for these analyses are summarized in Table 6.

A significant interaction was found between Reflective and Impulsive difference scores, $F\ (5,73) = 3.80$, $p < .01$, and therefore, further analyses were performed on Reflectives and Impulsives as classified on the MFF-SPT. In order to assess whether Reflective children maintain their scanning strategy across the modalities of vision and audition, a Hotellings Trace Criterion was computed on the difference scores of the transformed data. Overall, no difference was found between the scanning strategies Reflectives employed on the MFF-SPT and AIT, $F(5,73) = .04$. The same effect was found for Impulsives, $F(5,73) = .03$. These data suggest that the strategies which Reflectives and Impulsives employ in searching for the match to standard generalize across the modalities of vision and audition.

Order and School Effects

The order effects of test administration are confounded by school effects in that the order of administration was not counterbalanced within schools,

TABLE 6

Scanning Strategy Differences

Across the MFF-SPT and AIT

Micro-Measure	MFF-SPT Means	AIT Means	Univariate F[a]
O_s	.369	.620	.05
$O_{\bar{c}}$	.357	.300	8.60**
O_c	.285	.340	.02
A_o	.452	.460	.79
O_f	.309	.360	.05

Note: Multivariate $F(5,73) = 23.09$**

a $df = 1,77$

**$p < .01$

but only between schools, due to uncontrollable circumstances. A preliminary analysis, a Hotelling's T^2, indicated that there were significant overall differences on error and latency scores of the MFF-SPT and AIT between children receiving the MFF-SPT first and those administered the AIT in session one ($F(4,76) = 11.15, p < .01$). T-tests indicated that significant order effects existed for the MFF-SPT error and latency scores only. Children receiving the MFF-SPT first committed significantly more errors than those receiving the AIT first ($p < .02$). No order differences were found on either error or latency scores of the AIT ($p > .05$). Table 7 reports means, t-values and resulting probabilities for the order effects.

TABLE 7

Effect of Test Administration Order on

Classification Measures of MFF-SPT and AIT

Test	Order 1[a] $\bar{x}$	Order 2[b] $\bar{x}$	t
MFF-SPT			
Error	10.26	7.69	2.08*
Latency	2.53	2.65	-2.31**
AIT			
Error	6.57	5.92	0.56
Latency	2.69	2.71	-0.45

a Order 1 are those receiving the MFF-SPT in session 1.
b Order 2 are those receiving the MFF-SPT in session 2.

$df = 77$
*$p < .04$
**$p < .02$

DISCUSSION

The AIT was developed as a match-to-sample task to measure R-I in the auditory modality. Hypothesis 1 proposed that R-I could be measured in the auditory modality, that is, that children could be classified as Reflective or Impulsive on the basis of an inverse relationship between errors and latency on the AIT. The significant correlation of -.32 found between these measures indicates that Hypothesis 1 was confirmed. Increased time in searching for the correct match to standard resulted in a decreased number of errors. The meaningfulness of measuring R-I auditorally is evidenced by the significant inter-task correlations found between similar measures on the MFF-SPT and AIT. The MFF-SPT, a sequential presentation of the original MFF, was chosen as the standard against which the AIT was compared because over several years consistent negative correlations between errors and latency have been found. Further, performance on the MFF has been shown to be consistent up to two and one-half years (Messer, 1970) and thus the test established itself as an accurate measure of the R-I dimension. Similarities across the two modalities

in terms of errors and latency are indicative that the two tasks are measuring the same dimension. Beyond this, it was found that significant relationships existed between measures across tasks. Children committing few errors on the AIT took a longer time to respond on the MFF-SPT; those committing many errors on the AIT generally responded quickly on the MFF-SPT. The same relationships were found between MFF-SPT errors and AIT latency. Thus, it seems that the cognitive dimension of R-I is not restricted to the visual modality. Rather, the dimension exists in other modalities in which tests of response uncertainty are employed.

Similar findings were reported by Butter (1971) for the haptic modality. Butter found a significant correlation of -.72 between error and latency scores on the HMT, a match-to-sample task in the haptic modality. Further, he reports cross-task consistency in the number of errors committed and latency to first response between the modalities of vision and touch. From these two researcch efforts, it would seem that R-I can be measured in any modality in which a test of high response uncertainty can be devised so that the tendency to "reflect" over alternative choices leads to better performance whereas the children who act on "impulse" and select the first obvious alternative perform poorly.

Hypothesis 2 contended that children would maintain their classification as Reflective or Impulsive across the two modalities of vision and audition. The significant intertask correlations reported for error and latency in the two modalities attest to the cross-task consistency of the R-I dimension. In addition, the data indicating a high percentage children maintaining their classification across modality is persuasive support for Hypothesis 2. Fifty-five per cent of the sample maintained classification across the two tasks while less than 10% of the sample actually switched styles across modalities so that children were Reflective on one task and Impulsive on the other. Thus, 90% of the sample either maintained classification or crossed into an "unclassifiable" style on the second task. Butter (1971) reported that only 5% of his sample changed to an opposite style across the visual and haptic modalities. Thus, the two research efforts are consistent in their findings that classification on the R-I dimension does generalize across modalities. This would indicate that reflectivity and impulsivity are not a function of one perceptual system, but rather, there exists cognitive strategies which guide performance across modalities when performing on tasks of response uncertainty.

The third point of this research effort was to determine whether Reflective and Impulsive children

employ different scanning strategies in the visual modality and whether these differences would also be found in the auditory modality. Prior to testing differences between Reflectives and Impulsives, the effects of errors and latency were evaluated. The scanning strategy of children above the MFF-SPT error median were compared to those committing less errors than the median. Significant differences were found on every micro-measure with children committing few errors making more observations of the standard and all alternatives than those committing many errors. Similarly, children above and below the latency medians were compared on the MFF-SPT. Consistently, children with long latencies scored higher on each micro-measure than did children responding quickly.

Reflective and Impulsive children were directly compared in the scanning strategies they employed because children committing few errors or displaying long latencies made more observations of the micro-measures than did children committing many errors or responding quickly. As expected, significant differences were found between the two groups on the MFF-SPT. Reflectives made more observations of the standard, the alternative chosen as a match to standard, the laternative most frequently observed, and they observed more different alternatives than did Impulsives.

Siegelman (1969) has indicated similar findings. She reported that, on a task similar to the MFF-SPT, Reflectives made more observations of the standard, all alternatives combined, the chosen alternative, the most frequently observed alternative, and ignored less than two and one-half as many alternatives as did the Impulsives. If the two micro-measures of $\underline{O}_{\bar{c}}$ and $\underline{O}_{c}$, reported in this study, are combined, the result is the total number of looks to all alternatives and it is found that Reflectives do observe all the alternatives more than do Impulsives as Siegelman reported. Thus, the two studies coincide completely in indicating that Reflectives deploy more attention to every picture of the MFF (or modified version) than do Impulsives. This greater allocation of attention would obviously cause the increased latency of Reflectives and probably could account for the decreased errors as well.

The similar finding reported for differences between MFF-SPT Reflective and Impulsive children, in the scanning strategies they employed on the AIT, is powerful evidence that Hypothesis 3 was supported: differences between Reflective and Impulsive children's scanning strategies would remain consistent across the modalities of vision and audition. The Reflective children who made more observations toward the standard and all alternatives on the visual task also made more observations of these micro-measures in the auditory modality. Impulsives

consistently displayed less efficient scanning strategies across the two modalities.

This maintainance of differences between Reflectives and Impulsives would seem to explain why only 10% of the entire sample crossed from one cognitive style to the other across modality. If differences in scanning strategies between the two groups are maintained then resulting error and latency scores should also remain consistent.

However, even though children maintained classification across modality and differences between Reflectives and Impulsives were comparable on the MFF-SPT and AIT, there was still a need to test that Reflectives and Impulsives would maintain their strategies across the two tasks. It was reported that children regardless of cognitive style did not differ across modality in the scanning strategies employed. Only $\underline{O}_{\bar{c}}$, the number of observations of the alternatives not chosen as a match to the standard, was not comparable across tasks. There were more observations made to unchosen alternatives on the MFF-SPT than on the AIT and this difference was significant. It was hypothesized that Reflectives and Impulsives would both maintain search strategies across vision and audition. Although individual analyses were not performed on each of the micro-measures, the finding that differences were not significant across modality

in the overall scanning strategy of either Reflectives and Impulsives is meaningful. This finding is indicative that the manner in which children approach the tasks is a basic cognitive approach, not perceptually bound, and thus could affect performance on tasks other than R-I measures.

Overall, children did perform similarly on the MFF-SPT and AIT. Thus, the cognitive dimension of R-I can be measured in the auditory modality and this measurement is meaningful when compared to the visual modality. Some faults were found with the AIT though. First, the correlation between AIT errors and latency was not as high as expected. Previous data has indicated that errors and latency on visual measures of R-I have correlations in the high sixties. Further, Butter (1971) found errors and latency in the haptic modality to have a correlation of -.72 for the entire sample of children. The correlation of -.32 (accounting for only 9% of the common variance) in the auditory modality is well below these others. As an explanation for this, it was observed that many children were able to code the series of tones and spaces employed on the AIT and, therefore for these children, the task was not of high response uncertainty. Rather, the child may listen to an alternative and accept or reject it without hesitation. This is different from the visual MFF and Butter's HMT in that the latter tests

require the child to break the stimulus up into its component parts and make comparisons either between the alternative and the standard or between two alternatives.

This problem of lacking in response uncertainty could account for the unexpected findings that children with long and short latencies on the MFF-SPT did not differ significantly in the number of different alternatives observed on the AIT. If the child listens to one alternative and, by coding, can ascertain that it is the correct match, there is no need to test other buttons and therefore, the number of different alternatives observed would be reduced.

Another unexpected finding, that children differ across tasks on the number of observations made toward the alternatives not chosen as a match to standard, can also be explained by the AIT's lack of response uncertainty. On the MFF-SPT, it often requires many observations of an alternative before a difference can be found between two pictures. On the AIT, however, there was no need to continually listen to an alternative. With only one or two presentations, the child could determine whether the series of tones and spaces were identical to that of the standard. Therefore, once an alternative was listened to, it could be rejected immediately and there was no need to return. Thus,

differences would exist across the two tasks in the number of observations made to these alternatives.

The MFF-SPT involves differences in small details of the pictures (i.e., curved versus straight lines, long versus short lines, etc...). Not only are the differences small, but there are many visual cues to which the child must closely attend. For example, on one trial of the MFF-SPT, the child must look at the roundness of a face, height and position of the ears, direction of the legs, length of the tail, expression of the mouth and many others. On a visual (or haptic) task there are unlimited features which may be altered. On an auditory task, however, there are few stimulus parameters which can be changed. By changing too many elements of the auditory pattern, the child would become confused and the test would be too difficult. Therefore, it appears to be a difficult task to make the AIT have more response uncertainty without increasing the difficulty of the test too much. However, even though it seems that the MFF-SPT and AIT do have some basic differences, results have indicated that they are measuring the same dimension. The inadequacies of the AIT could only have weakened the chances of reaching significance in these analyses. Because the similarities were found to be strong, it is concluded that R-I is a very important cognitive dimension which is not limited to the visual

modality. Rather, the dimension or predilection toward particular cognitive styles and strategies is so robust and generalized within the cognitive framework, it can be tapped across several modalities.

The order of test administration was not expected to have significant effects upon performance. However, such effects were found. It was reported that children receiving the MFF-SPT first committed significantly more errors and responded with shorter latencies than children who were administered the AIT in Session 1.

Butter (1971) reported that when children were trained in the haptic modality to become more Reflective, this training transcended into the visual modality. However, training in the visual modality did not affect performance on the haptic task. Butter concluded that asymmetrical transfer of training was found because the HMT is a more difficult test and therefore elicited more attention and motivation. Beyond this, he proposed that the haptic task required the child to be more actively involved in the situation than did the visual MFF. The combined effect of a more difficult test and higher motivation or task involvement was used to explain the unilateral training effects.

The AIT was not administered as a training device nor were the instruction given at the outset of the test any more helpful or instructive than those designed for

the MFF-SPT. However, it appears that by simply being administered the AIT, children did modify their behavior to come degree on the visual counterpart. It is hypothesized that possibly Butter's explanations would apply here. Children became more involved on the auditory task and therefore it affected later performance. This author would propose that a replication of Butter's research with the inclusion of the AIT, be carried out to test whether there is actually asymmetrical transfer across the three modalities of vision, audition, and touch.

The question of the cross-modal generality of the R-I dimension was not construed as a purely empirical hypothesis. Rather, there are practical implication for this research. Of greatest interest is the meaningfulness of this research effort in future attempts at predicting reading ability of children. Reading performance and auditory discrimination ability have been found to be related (Butler, 1972; Kagan, 1965b; Kalash, 1973; Lesiak, 1970). Furthermore, in view of the relation between these same reading measures and visual MFF performance, it seems appropriate to theorize that auditory measurements of R-I may be sensitive predictors of reading readiness.

It is thought that the cognitive dimension of R-I should not be used as a basis for a remedial reading program. That is, if Impulsive children are found to be poor readers, there seems to be no indication that by modifying their style they will assume good reading habits. Although success has been recorded in changing a child's cognitive style from Impulsive to Reflective, there has never been a reassessment of reading performance following the modification program. It would seem that the role of R-I in regard to reading should be more of a problem-prevention system. Children could be assessed as to what cognitive style they operate under before reading instruction begins. If children are found to be Impulsive, modification of cognitive style could be affected so that the children are Reflective prior to the start of reading programs. In this way, problems can be prevented rather than attempting to solve them after the child has evidenced poor reading ability. Impulsivity may not <u>cause</u> the child to read poorly everyday. Rather, the child's Impulsivity may cause him to fail to learn to read correctly at the beginning and therefore read poorly. A prevention program established in the first grade could potentially avoid these problems.

SUMMARY

Fourth-grade males and females were individually administered the MFF-SPT and AIT, which are both match-to-sample tasks devised to measure the cognitive dimension of R-I. The MFF-SPT is a sequential presentation of the established MFF which measures the dimension in the visual modality. The AIT was designed for this research to measure R-I auditorially. Overall, this research effort has found that R-I can be measured in the auditory modality and that this measurement has meaning when compared to performance in the visual modality. A significant correlation of -.32 was found between errors and latency on the AIT. Furthermore, significant correlations were found to exist between similar measures across the two tasks. It was also found that children maintain classification across modality. Of the 81 children tested, 58% maintained their classification across visual and auditory tasks and, only 10% changed cognitive styles across modalities so that they were Reflective on one task and Impulsive on the other. However, when the AIT was administered prior to the MFF-SPT, changes in classification were

more frequent because more Impulsives became Reflective than when the MFF-SPT preceded the AIT. It was suggested that the increased difficulty of the AIT and greater involvement which this harder task requires possibly accounts for the asymmetrical effects.

Scanning strategies across modalities were investigated. It was found that Reflectives and Impulsives not only differ in their error and latency scores but that they also employ very different scanning strategies. These differences were observed in both modalities. Consistently, Reflectives made more observations of every micro-measure analyzed. However, children within a classification maintain scanning strategy across modality. This cross-modal consistency was found not only for Reflectives and Impulsives but also for all children in the sample.

The AIT was found to be a meaningful measure of R-I in the auditory modality with some reservations. The overall concept of the AIT seems to be appropriate, however, it appears that the test should be modified somewhat to impose higher response uncertainty. It was suggested that if the test could be changed in some way to avoid the possibility of coding, the response uncertainty may be heightened.

Finally, it was suggested that R-I in the auditory modality be assessed in relation to reading performance. It was hypothesized in future research that there may be a positive relationship between reading failure and auditory impulsivity and that the AIT or a slightly modified version could be employed at an early age to spot potential problem readers before the problem actually arises.

Appendix A

The following instructions were given for the AIT: "Today, we are going to play a matching game. When you push any of these buttons (The experimenter points to the 5 buttons on the stimulus panel), you will hear a group or pattern of musical notes with spaces between them. One button at the bottom (the experimenter points to the 4 alternatives) will play the exact same group or pattern of notes and spaces that this button at the top plays (the experimenter points to the standard). The rest of these buttons will play different groups of notes and spaces (the experimenter points to the alternatives). In this game, you see if you can find the one button down here (point to alternatives) which plays the exact same group of notes and spaces that this button up here plays (point to standard). There can be no differences between the buttons. You may push any button you want, as many times as you want and in any order that you want. In fact, there is only one rule in this game that that is that you can push only one button at a time and cannot push another button

until the first one finishes playing all of its notes. Remember, only one button down here (point to alternatives) plays the exact same group of notes and spaces that this one does (point to standard) with no differences between them. Do you understand?"

Note. If the child indicated that he understood the instructions and was able to find the correct alternative on the first two practice trials, the experimenter continued immediately with Trial 1. However, if the child did not understand or performed poorly on the practices, the instructions were repeated. If, after this the child still did not perform correctly, he was asked to tell the experimenter what the instructions were. The experimenter then clarified any misunderstandings that the child had.

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