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ABSTRACT

Harvard Project Zero provides a series of technical research reports which study artistic creation and comprehension as a means toward better art education. The emphasis of the research is to improve art education through a better psychological understanding of symbol systems and media of art and through better understanding of the perceptual, motor, and cognitive processes involved in dealing with art. This third technical report in the series studies whether preadolescent children can learn to classify paintings consistently by style or by figure. Subjects at the seven- and ten-year age level were given a pretest, a seven-week training session, and a number of post- and transfer tests. Children at both age levels demonstrated the ability to sort paintings according to a consistent criterion. The older group could more readily alter the basis of its classification and their style sensitivity was not found to be dependent on concrete operational thought. Results of transfer tests given to the experimental and control group indicated that practice in looking at pictures may increase sensitivity to the textural aspects of visual display. (Author/DE)

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Basic Abilities Required
For Understanding and Creation
in the Arts

Technical Report No. 3

THE DEVELOPMENT OF SENSITIVITY TO FIGURAL AND STYLISTIC ASPECTS OF PAINTINGS

by

Howard E. Gardner

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HARVARD PROJECT ZERO
BASIC RESEARCH IN ART EDUCATION

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617-495-4342

Project Zero is a basic research program at the Harvard Graduate School of Education conducting a theoretical and experimental investigation of creation and comprehension in the arts and of means toward better education for artists and audiences. A brief explanation of the Project's development and current work, along with a list of other reports, can be found at the end of this document.

The Development of Sensitivity to Figural and Stylistic Aspects of Paintings

Abstract

To determine whether pre-adolescent subjects can learn to classify paintings consistently by style or by figure, matched groups of subjects at each of two age levels (7 and 10) were given a pre-test, a seven week training session, and a number of post and transfer tests. Subjects at both age levels demonstrated the ability to sort paintings according to a consistent criterion. The older group could more readily alter the basis of its classifications when instructed to do so; style sensitivity was not found to be dependent upon concrete operational thought. Results on transfer tests given to the experimental subjects and to a control group indicated that practice in looking at pictures may increase sensitivity to the textural aspects of visual displays. Strategies used by subjects and the role of Gestalt perception and operational thought in style sensitivity are discussed.

Howard Gardner has recently completed his doctoral studies in Developmental Psychology at Harvard University. He is interested in the development of abilities involved in using symbol systems, particularly those employed in the arts.

Acknowledgments

This technical report is substantially the same document as a doctoral dissertation submitted to the Department of Social Relations, Harvard University, in partial fulfillment of the requirements for the Ph.D. in Social Psychology. I would like to thank the following individuals for their help throughout the course of the study: Professor Roger Brown, my advisor; Professor Marshal Haith; Professor Rudolf Arnheim; Jeff Lister; Ellen Bussard; Professor John Kennedy and Dr. David Perkins of Project Zero; and my wife Judy. I am also indebted to the students and staff of the Davis and Underwood Schools in Newton, and to Mrs. Carmella Nadeau and Mrs. Audrey Cooper in particular.

This research was supported principally by the National Science Foundation through Grant GS-2625 to Mr. Edward Pattullo and also by the Office of Education, through a grant to Harvard Project Zero.

CHAPTER 1

Introduction

The stage at which children become able to perform complex cognitive tasks and the manner in which they acquire these abilities have been dominant issues in developmental psychology. Investigators have examined such capacities as concept formation, operational and hypothetico-deductive thinking in terms of variables like age, sex, developmental stage, and amount of training. Recently a number of researchers in the area of cognitive psychology have probed the development of style sensitivity in various media: this trend has reflected a belief that style discrimination is a complex form of cognition, involving objects drawn from daily experience, susceptible to laboratory testing, of interest but not overly familiar to children. The study to be described here is concerned with the factors which lead to style sensitivity, the age at which it can be trained, and the relationship between this capacity and other kinds of perceptual and cognitive skills.

While artistic perception has been investigated since the inception of scientific psychology (Fechner, 1876) empirical studies of style perception are scarcely a decade old. Machotka (1963, 1966) examined the reasons children gave for their painting preferences and found that stylistic considerations (manner of representation) did not appear as a rationale until adolescence, he related this finding to Inhelder and Piaget's claim (1958) that formal operations, in particular the capacity to deal with hypothetical possibilities, were a precondition for awareness of alternative methods of representation. Walk (1967) and Tighe (1968), treating style recognition as concept formation, demonstrated that adult Ss had little difficulty in learning to recognize the style of a particular artist after thirty to forty minutes of practice. Frechtling and Davidson (1970) gave Ss of different ages sixteen paintings from assorted schools and asked Ss to classify them on any basis they chose. These authors found that subject matter was the strongest basis for grouping at all age levels and that style was a significant grouping only among adults. They concluded:

> The evidence suggests that in order to teach a child to respond to artistic style, it may be necessary not only to expose Ss to positive instances of the concept but also to provide specific training to reduce attention to other, preferred concrete attributes. . . it is only after the development of concrete operations is complete that an interest in such complex variables as style begins to appear (1970, pp. 79-80).

Walk, et al. (1970) asked schoolchildren to place the appropriate artist with the rest of his "family" of paintings; 8 year olds gave 86 percent correct responses and six year olds gave 61 percent correct responses. Generalization from Walk's results must be cautious, however, for they were based only on four artists; the artists were of widely different styles (Picasso Cubism, Seurat, Durer, and Matisse); and the paintings were usually presented for matching in a non-random order.

Gardner has investigated the development of style sensitivity in a number of artistic media, finding evidence for sensitivity to literary style among a

small proportion of six and eight year olds (Gardner and Gardner 1971) and sensitivity to musical styles among a sizeable number of children at that age (Gardner 1971b). In most of these studies, sensitivity to style has been operationalized as the capacity to group together works done by the same artist. Style has been defined as all those properties of an artist's works which may aid one in recognizing further works by the artist; sensitivity to style is thus equivalent in these studies to artist recognition. Theoretically, any factor, including subject matter, artist's signature, and even such "external" cues as location of the work or age of the canvas may facilitate style sensitivity and hence fall within this broad formulation of style. As a practical matter, however, it has been advisable in these studies to eliminate the more adventitious cues, like signature, in order to make Ss focus on those aspects of aesthetic objects which are considered more central to artist's style, like texture, composition, and expressiveness (Gardner, 1971a).

Using various procedures, Gardner has examined the development of general style sensitivity in the visual arts: his studies contrast with those of Walk and his associates in which interest centered on mastery of a few specific artists rather than on the capacity to classify consistently by style across the entire range of artists working with a medium. In an initial investigation which employed a match-to-sample procedure, Gardner (1970a) found that adolescent Ss were significantly better than younger Ss at classifying paintings by style when cues of subject matter or dominant figure (Rubin, 1921) competed with stylistic cues, but that when such conflicting cues were eliminated (as in the case of abstract works) elementary school children performed at essentially the same level as adolescents. Gardner (1970b) conducted a companion investigation in which these misleading cues were minimized and found that older pre-adolescents (aged 11) improved their performance but younger children (aged 6) did not.

Having determined that figural and subject matter aspects (e.g., dominant geometrical forms or salient objects depicted) tend to minimize stylistic sensitivity among pre-adolescents, Gardner and Gardner (1970) devised a paradigm in which these cues were pitted against one another. Sets of four paintings were assembled in which three alternative methods of classification by pairs were possible. The sets featured two paintings by artist A and two by artist B: each artist had painted the same two kinds of subject matter or dominant figures (1 and 2). Thus a specimen set would include a still life by van Gogh, a portrait by van Gogh, a still life by Manet, and a portrait by Manet. In the first condition Ss were instructed to make two piles, each containing two paintings, and to place together those paintings which "belong together" because they "look alike." Ss ranging in age from first grade to college sophomores grouped overwhelmingly by subject matter or figure. When instructions were altered for a matched population, and Ss were asked to group those pairs which had been done by the same painter, Ss aged 11 and 19 significantly changed the basis of their sorting and grouped primarily by style; younger Ss (aged 6, and, in a pilot study, 8-9) did not change the basis of their sorting. It was concluded that until the years immediately preceding adolescence, most children are not aware that artistic works by an individual may possess strong features in common, even if the dominant figures or objects represented are very different. For children, then, sorting by style reduces to sorting by color, subject matter, or "general similarity," strategies adequate only when there are no strong but misleading cues.

The attempt to determine the age at which general style sensitivity becomes possible is complicated by two factors: if direct verbal instructions like "sort by style or by painter" are used, these instructions are meaningless for young Ss; if Ss are simply allowed to classify on their preferred basis, strong habits of attending to color, form, or subject matter will predominate. Preliminary explorations have indicated that style sensitivity is probably not readily achievable through verbal instructions and that an intensive exposure to many sets of paintings under conditions of correction and reinforcement is more likely to indicate whether pre-adolescents have the capacity to sort by style.

Since no direct instruction or discussion about style is included in such training sessions, it must be assumed that there are sufficient clues within the painting reproductions themselves to allow a subject to sort by style. These internal cues, having to do with the quality of the brushstroke, the composition, the manner in which details are executed, and, above all, the microstructural regularities which extend across figure and ground are to be termed texture.

Gibson (1950) has supplied a useful introduction to the notion of texture as it will be employed in the present study. Using an idealized model of perception, in which the organism responds to spots of light having two possible degrees of brightness, he contrasts homogenous retinal stimulation (where all spots are light -lllllll- or all are dark -ddddddd- and no distinctions can be seen) with ordered stimulation where there is a single step ---lllllddddd--- or where there are cyclical or alternating changes --lllddd lllddd. He comments

> It is a reasonable hypothesis that when such an order is found in both dimensions of an array of elements there will occur the visual quality of texture. . . . and this is the stimulus correlate of a visual surface. The varieties of texture are innumerable, of course, but the varieties of a cyclical order of elements could be equally enormous . . . if physical surfaces have regular structures peculiar to them, as wood, cloth, or earth have, the regularity will be projected in a focussed image (p. 65).

As an example of texture, Gibson describes an array with repeating changes in two directions, such as this one:

```
lldd lldd lldd lldd
ddll ddll ddll ddll
lldd lldd lldd lldd
```

In principle, Gibson maintains, the complex features of the world and the features of artificial displays as well should be describable in terms of this model. Though he himself has not expanded upon this claim, recent work by Julesz (1969) on computer-generated patterns has revealed that certain statistical regularities among black and white dots are perceived effortlessly as distinctive textures, while other regularities, comparable in mathematic complexity, are not. Such findings suggest that operationalization of the diverse textures discernible in pictorial displays should be possible. Drawing upon work such as this it will be assumed in the present study that paintings by an artist possess certain microstructural or textural regularities

(mathematically specifiable in principle) and that these will be of considerable assistance to the subject engaged in style detection.

Since style has been defined as the range of cues which can lead to a correct grouping by artist, textural aspects are clearly only a subset of the cues relevant to style detection. The connoisseur makes use of external aspects, such as the age of the canvas, and other internal aspects, such as color use or subject matter. In the present study, however, efforts have been made to remove or to render as competing with classification by style as many of these other cues as possible; accordingly, textural aspects will constitute the principal cues for style recognition. Indeed it is hypothesized that any S in the study who develops a sensitivity to texture will exhibit style sensitivity and that sensitivity to texture will also transfer to non-aesthetic materials. In addition to its more direct concerns, the study may be viewed as an attempt to determine the construct validity of two aspects of pictorial displays: figure and texture.

Though selected cognitive tasks may be judged as all-or-none phenomena, sensitivity to style is clearly a matter of degree. Infants and animals appear to possess a certain amount of textural sensitivity (Gardner, 1971a) while even the most accomplished connoisseur will occasionally err. Accordingly, three criteria differing in stringency have been set forth as indices of style sensitivity: a simple improvement in performance as a result of training; the capacity to perform at a certain level on a post-test; the capacity to perform at a higher level on the post-test. The three criteria will be called "improved", "probably sensitive" and "definitely sensitive".

Plan of the Study: The study took place over a three-month period and proceeded according to the following plan. During the first week all Ss at two age levels took a pre-test in which their general classificatory tendencies were investigated. Over the next seven weeks Ss were given weekly practice in sorting paintings according to one of two strategies. After the training, Ss took four additional tests at weekly intervals: a post-test, to determine whether learning had occurred; two transfer tests; a repetition of the post-test with instructions to sort according to the alternative criterion. Directly after the second administration of the post-test, the younger Ss were given a series of tasks in order to determine their level of operational thinking. A flow-chart of the study appears in Table 1.

The study sought answers to the following questions:

(1) Can children learn to sort painting reproductions consistently by style or consistently by figure?

(2) What are the learning trends at two age levels?

(3) Does exposure without differential reinforcement to numerous sets of paintings enable the individual trained in one way to sort in the other way as well?

(4) Do the two classificatory tendencies under investigation transfer to perceptual tasks outside the arts?

Table 1

Flow-Chart of Study

Week	1	2-8	9	10-11	12
Test	Pre-test	Training Sessions	Post-test 1 (same as pre-test)	Transfer Tests	Post-test 2 (same as pre-test)
Subjects	All Ss take without reinforcement	Figure Group reinforced for grouping by figure Style Group reinforced for grouping by style	All Ss take without reinforcement		Figure Group instructed to sort by style Style Group instructed to sort by figure

In addition to these motivating questions, evidence was sought on a number of other issues: the amount of time (latency) involved in making sortings; sex differences in style sensitivity; the effects of a simple sorting condition without reinforcement; the relationship of stylistic sensitivity to operational level of the subject; the diversity of strategies used by Ss in the two groups; the relationship between sensitivity to painting styles and sensitivity to styles in other aesthetic media.

CHAPTER 2

Methods

Subjects: Ss were selected at random from two elementary schools having a mixed though predominantly middle class population. All Ss came from one school, except for the controls in the transfer test.

The group involved in the major study consisted of 48 individuals: twelve males and twelve females at each of two grade levels--second and fifth. The modal age of the Ss at the time of the first post-test was 7 and 10. Twelve additional Ss took the pre-test but were not included in the final population for the following reasons: one subject moved during the course of the study; one parent objected to the inclusion of his child in the study; three second graders and three fifth graders made over 8 out of 20 sortings by style on the pre-test and were dropped according to a prearranged plan; two Ss at each age level were placed in control groups where they were exposed to the paintings but received no reinforcement. The Ss in this condition became restless and showed no change in their sorting behavior; as a result this phase of the study was discontinued. Because of the decision to select Ss randomly, a number of Ss with behavioral or learning problems were included in the experimental population.

The group which served as controls for the transfer tests consisted of 96 Ss matched in age and sex with the experimental population. Half of this group took one transfer test; the other half took the other transfer test.

Materials

Painting Sets: Following the model of Gardner and Gardner (1970), two hundred and thirty sets of paintings were devised, each set consisting of reproductions of four paintings, two by one artist (A), two by another (B). One painting by artist A and one painting by artist B had strong figural properties in common (i.e., similar subject matter or similar compositional shapes, such as a central triangle, or a predominantly horizontal layout); the other painting by artist A and artist B also had strong figural aspects in common but these were always markedly different from those shared by the first pair of paintings. The reproductions were taken from several collections and represented a wide range of schools and periods including non-Western and abstract works. No painter was heavily represented; paintings were trimmed when necessary to prevent recognition on the basis of signature; efforts were made to avoid sets in which color, size, medium, or other salient cues would coincide with style and to include sets in which these cues competed with style. The sets were pilot-tested on selected adults and children and were shown to three judges who eliminated pairs inconsistent with the guidelines. Then twenty sets were chosen to be used in the pre- and in both post-tests and seven other groups of twenty sets each were assembled for use during the training sessions, making a total of 160 sets to be used in the study. The training sets did not differ greatly in difficulty from one another but some sets which were difficult to group by figure were included in the middle and latter weeks of the training, in order to maintain the interest of the figure group and to encourage Ss to consider carefully the figural aspects of the paintings. No practice items were used for the pre- and first post-tests but five painting sets from earlier weeks were used as practice items on the second post-test.

For each set three ways of classification were possible: by style (or painter), by figure (or subject matter), and a third anomalous way which cut across the other classifications. This third way was critical in determining whether Ss were becoming sensitive to style, or simply learning not to group by figure.

Transfer Tests: Two tests were devised, piloted on ten Ss at each of three age levels, revised, and then administered at the appropriate time to the experimental Ss and to a control group. The Figure Test (FT) was so constructed that Ss trained to sort by figure might perform well on it; the Texture Test (TT) was so constructed that Ss trained to sort by style (or texture) might perform well on it.

FT: The Figure Test featured a series of twenty large black cards each having five pictures mounted on it, a standard item on the left-hand side and four test items in a rectangular configuration on the right side of the card. Ss were given a verbal introduction to the materials: (pointing to the left side) "Here is a picture of something. Do you know what it is?. . . . Now take a look at the pictures on the other side of the card. Can you tell me which is a picture of the same thing?" Through a paraphrase of these instructions and the administration of four simple practice items, Ss came to understand that they had to choose that test item which pictured a member of the same class as the standard item. Pictures were taken from a variety of sources, such as magazines and textbooks, and covered a range of classes: animals, birds, biological processes (e.g. mitosis) chemical preparations (e.g. the Solvay process). In each case the correct answer was a picture of the same object, with contour and figural properties in common, but having a distinctly different textural quality; one incorrect answer had strong textural cues in common with the standard item but no strong figural affinities; two other incorrect answers had neither strong figural nor strong textural affinities with the standard. To remind Ss of the task, four simple items were included at various points throughout the task proper; these items were not included in the scoring. It was hypothesized that Ss trained to sort paintings by figure would make more figure (and hence correct) choices, while Ss trained to sort paintings by style would make more textural (and hence more incorrect) choices.

TT: The Texture Transfer Test included parallel preparation, number and range of items, instructions and administration. Ss were shown a portion of a picture on the left side of the card (standard) and four other portions of pictures on the right side of the card (test items). They were asked to point to that test item which looked like it came from the same picture as the standard item. Again verbal instruction was minimized and the task was conveyed through the inclusion of simple examples. Ss were only told (pointing to standard) "Here is part of a bigger picture. Can you tell me which of the parts over here (pointing to test items) came from that same bigger picture?" Pictures were of materials or organisms which the children would not recognize either because the subject matter was unfamiliar or because the picture was greatly magnified or reduced. It was assumed that the two portions of the picture (e.g. parts of a cloud, cell, constellation, or tissue) would have strong textural properties in common and that Ss trained to attend to stylistic (or textural) aspects of paintings would be more aware of these textural properties. To mislead Ss with figural training, an incorrect answer which featured a figural property in common but which differed markedly in texture from the standard was included. For example, an incorrect choice would have the same dominant central mass as the standard item but an

entirely different texture. Two other incorrect answers with neither strong figural nor strong textural properties in common completed the test items for each card. It was hypothesized that Ss trained to attend to textural aspects of paintings would perform better on this task than those trained on figural aspects.

Both transfer tests were devised to test the hypothesis that sensitivity to figure or to texture extends beyond the realm of the arts and is manifest in other kinds of pictorial materials, such as those used in scientific education. Each set of test items consisted of two pictures which, in the opinion of three judges, had strong figural or textural aspects in common with the standard items and two pictures without such similarities (but not of course devoid of any similarities). Because these materials were new and relatively untested, this part of the study was the most provisional. It was anticipated that transfer from the training might exist and yet not be manifested on these two particular transfer tests.

Procedure: At the start of the first week Ss were put at ease through informal conversation and then were shown the first set of paintings. They were told: "Here are some pictures. I want you to look at all of them carefully and then put together those paintings which you think look most alike. Make two piles with two paintings in each pile." These instructions were paraphrased by E and d Ss were not allowed to proceed on this or any other tests until they gave a correct paraphrase of the instructions. No feedback was given on the twenty items but Ss were generally encouraged. At the conclusion of the first week, Ss were given a little prize and asked not to discuss the session with their classmates.

After all Ss had been pretested, their protocols were scored. Those Ss who were ineligible were eliminated from the population and the rest of the population was divided into two groups: a figure group (FG) which would be reinforced verbally for grouping by figure, and a style group (SG) which would be reinforced verbally for grouping by style. Each age level had 6 girls and 6 boys in a FG, 6 boys and 6 girls in a SG. The two groups were matched by their scores on the pre-test, with both having approximately the same proportion of high (5-8 style responses) and low (0-4 style responses) scores. So that the groups would also be matched in intelligence, motivation, and learning or emotional difficulties, the lists were reviewed with the teachers, who suggested a few modifications. After this procedure it was assumed that the figure and style groups were adequately matched.

Ss returned for the second week of testing and were told: "I want you to make groupings of paintings again but this time there is going to be a special way of doing it. Try to figure out the special way. I will tell you whether you are right; and I will show you the special way if you try it another way. We'll be doing this for some weeks and if you try your best to learn the special way, you will get a prize at the end." Ss then sorted each of the twenty sets of paintings, and received corrections and encouragements from E. At the end of the session they were told they were learning well and asked not to talk to classmates.

A similar procedure was followed with a different set during each of the six succeeding weeks of training. A record was kept of performance, and Ss were given little tokens to keep track of each correct answer. Ss and E together set up performance targets each week but these were not emphasized.

After the training, Ss were told on the following week: "Now I'd like to see how well you've learned the special way." The pre-test was administered as a post-test and Ss were not told whether they answered correctly. At the conclusion of the session all Ss were thanked and received a prize.

Ss returned in the two succeeding weeks to take the transfer tests. They were told: "Here are some new games which I'd like you to try out. You can tell me what you think of them." The instructions outlined above were administered. Ss were encouraged to do well but the informal atmosphere was preserved.

In the last session, Ss were once again given the pre-test. They were told: "Today I'd like to see if you can match the paintings another way." E demonstrated the "other way" (figure for SG; style for FG) on three items and Ss were allowed to practice with correction on two additional items. Thereafter there was no feedback but general encouragement. Immediately after this testing, all the younger Ss went to another E who gave them four Piagetian tasks in order to ascertain their operational level. The tasks were conservation of substance (Piaget et al., 1965); seriation of sticks; and two class-inclusion problems (Inhelder and Piaget, 1964). Following Piaget's procedure, Ss were rated from stage I (non-operational) to stage III (operational) on each problem and an overall score of operativity was computed.

Two experimenters conducted the study, each working with half of each subject group throughout the study. Relevant variables, such as order of the training sets and order of the transfer tests, were counterbalanced. A latency measure was taken on each response and then converted into a seven point scale: immediate response, 1-5 seconds; 6-10 seconds; 11-20 seconds; 21-30 seconds; 31-60 seconds; more than one minute. The study engendered considerable interest among Ss and non-participants and, except for the four control Ss in the non-reinforcement condition, no motivational problems arose.

CHAPTER 3

Results

Training of Figure and Style Sensitivity: The first post-test.

Success in learning the two classificatory modes can be ascertained by a comparison of an S's score on the pre-test with his score on the post-test. A series of non-independent three-factor repeated-measures analyses of variances were performed on the scores received on the two tests, with age and sex as between-subject variables and test-form as within subject variable. The change in number of s, f, and o responses given by the two groups will be reviewed first.

s responses: In the first post-test the figure group (FG) significantly decreased its number of style (s) responses ($F = 26.93$, $df = 1, 20$, $p < .01$); the style group (SG) significantly increased its number of s responses ($F = 52.07$, $df = 1, 20$, $p < .01$).

f responses: In the first post-test, the FG significantly increased its number of f responses ($F = 16.51$, $df = 1, 20$, $p < .01$); the SG significantly decreased its number of f responses ($F = 117.36$, $df = 1, 20$, $p < .01$).

o responses: In the first post test, the FG did not change the number of anomalous (o) responses ($F < 1$, $df = 1, 20$, n.s.); the SG increased its number of o responses ($F = 7.92$, $df = 1, 20$, $p < .025$). The increase in the number of o responses must be interpreted with caution, however. The absolute number of o responses was very small, and one fifth grader accounted for nearly half the o responses of the whole fifth grade population in the post-test (13 of 27).

Since there was a significant increase in the number of o responses given by the SG on the first post-test, the number of o and s responses given by SG Ss on the first post-test was compared. All the younger Ss and 11 of 12 older Ss gave more s than o responses on the post-test ($p < .01$- binomial distribution). This result, together with the above analyses, refutes the possibility that SG Ss were simply learning not to sort by figure.

interactions and other effects: In addition to the effects of the test, these analyses also showed a significant age effect on the s responses of the SG ($F = 4.40$, $df = 1, 20$, $p < .05$): an age effect on f responses of the SG ($F = 6.80$, $df = 1, 20$, $p < .025$); and an interaction of age and test on the f responses of the SG which approached significance ($F = 4.15$, $df = 1, 20$, $p < .06$). These effects and interaction indicate that the older Ss consistently gave more appropriate responses in each testing condition. No sex effects or interactions of sex with other variables were significant for any other analyses: accordingly the sex variable was dropped from subsequent analyses.

The principal features of these results can be readily seen in Figures I, II, and III. These graphs not only reveal the great disparity in responses between pre- and post- tests but also provide supplemental information about the trajectory of stylistic and figural sensitivity. Figure I which traces

Figure I

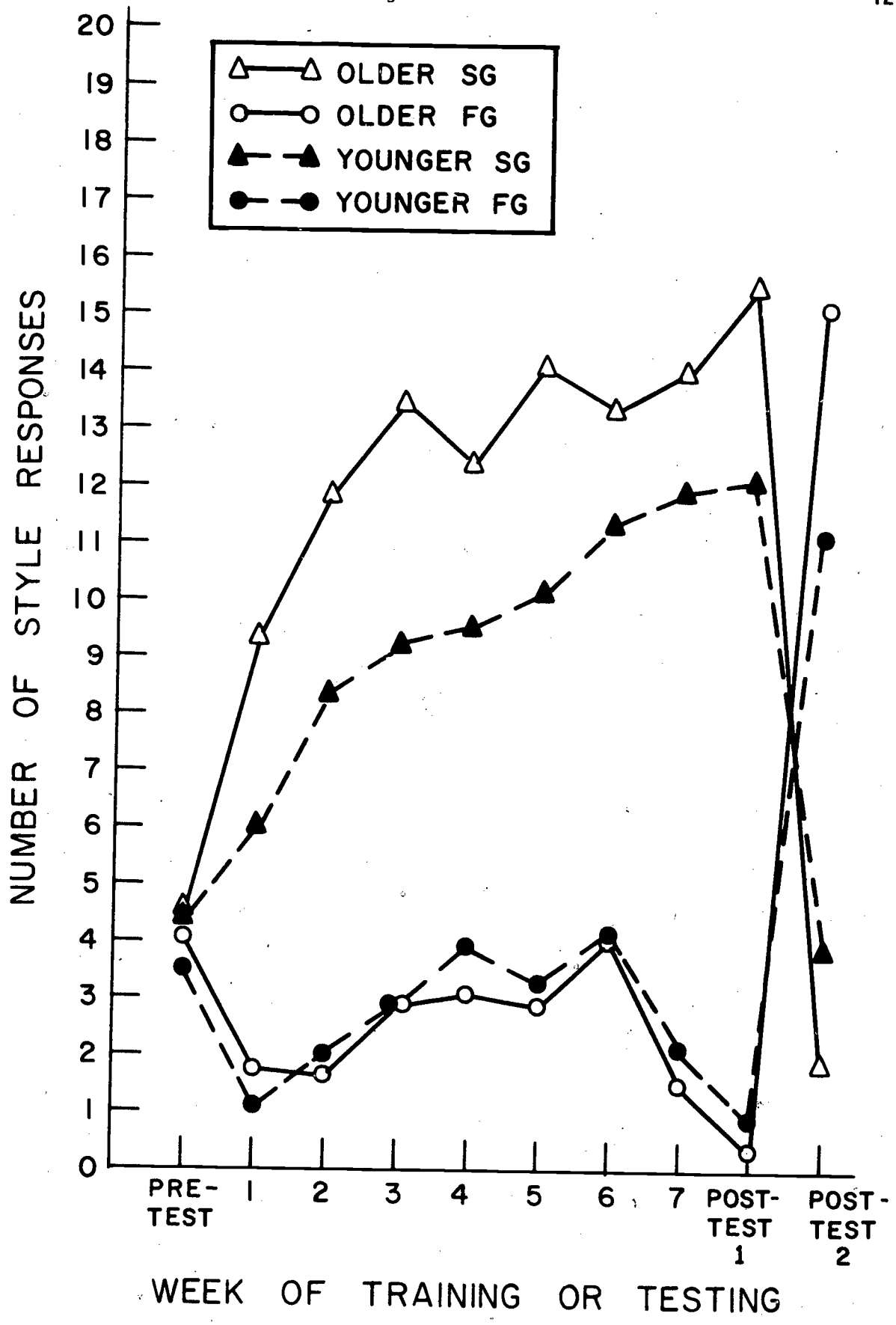
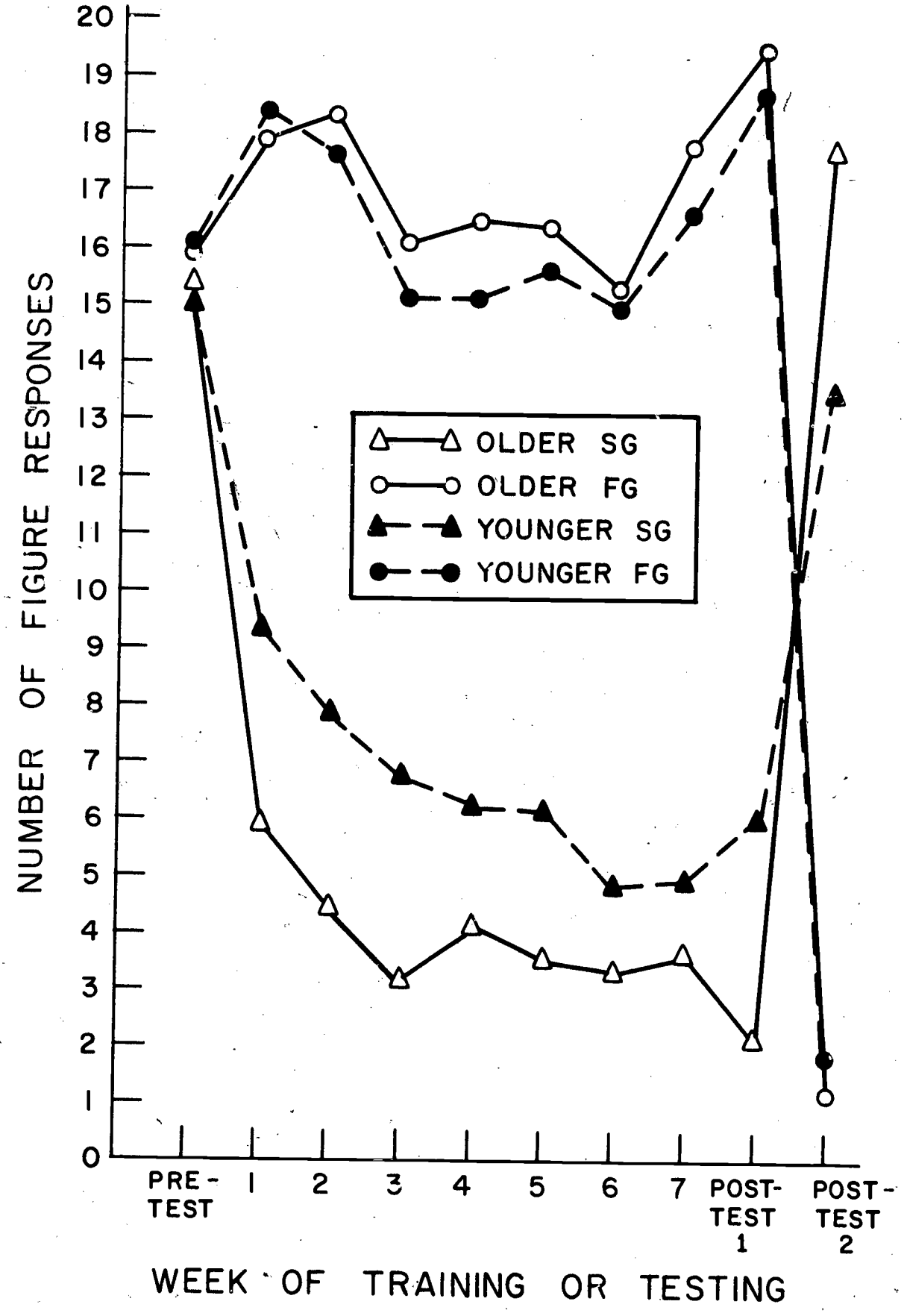

OLDER SG
OLDER FG
YOUNGER SG
YOUNGER FG
NUMBER OF STYLE RESPONSES
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
PRE-TEST
1
2
3
4
5
6
7
POST-TEST 1
POST-TEST 2
WEEK OF TRAINING OR TESTING

Figure II


NUMBER OF FIGURE RESPONSES
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18
17
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15
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13
12
11
10
9
8
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6
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4
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2
1
0
OLDER SG
OLDER FG
YOUNGER SG
YOUNGER FG
PRE-TEST
1
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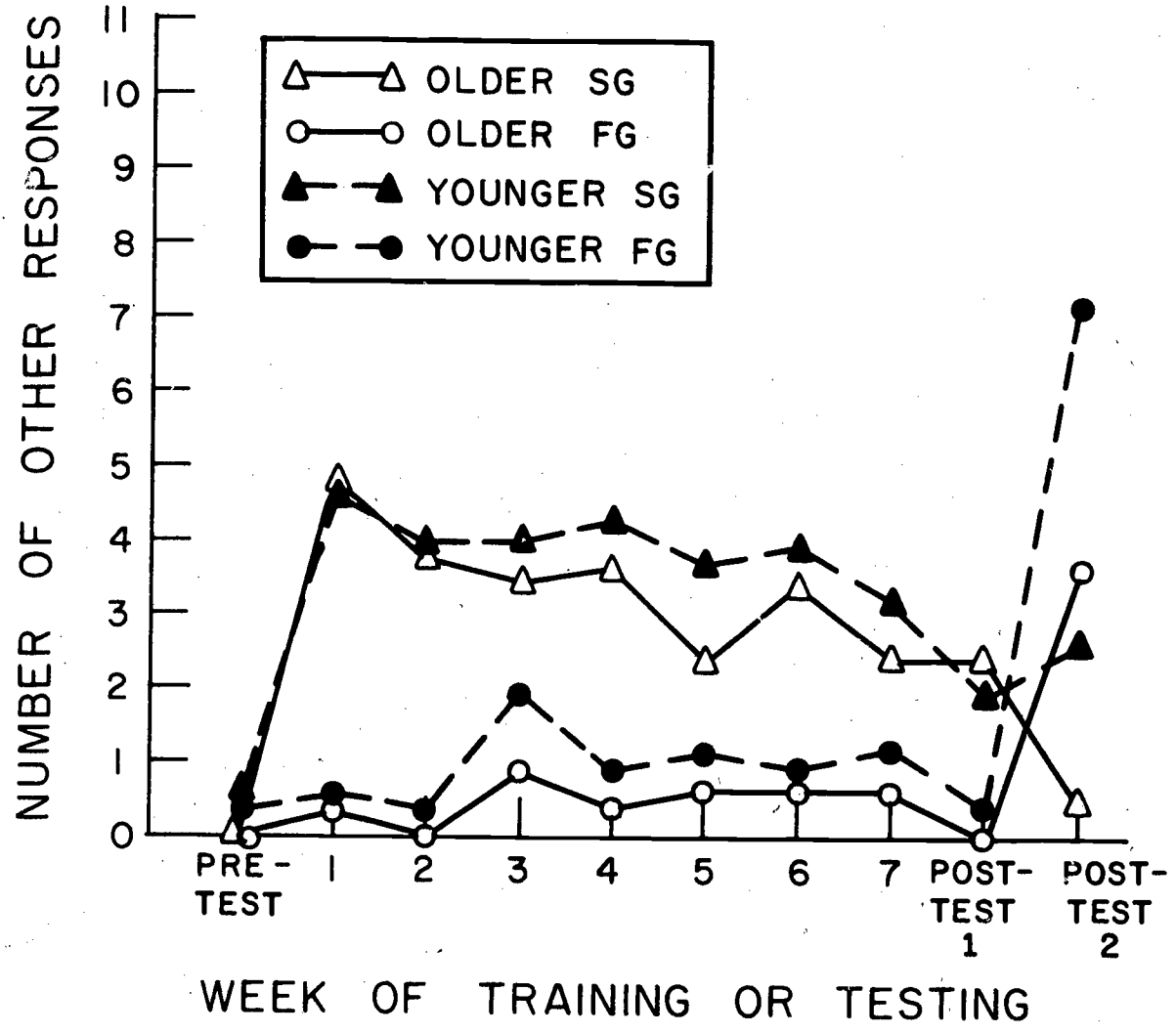
5
6
7
POST-TEST 1
POST-TEST 2
WEEK OF TRAINING OR TESTING

Figure III


NUMBER OF OTHER RESPONSES
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1
2
3
4
5
6
7
8
9
10
11
OLDER SG
OLDER FG
YOUNGER SG
YOUNGER FG
PRE-TEST
1
2
3
4
5
6
7
POST-TEST 1
POST-TEST 2
WEEK OF TRAINING OR TESTING

the change in the number of s responses suggests a slight increase in s responses given by the FG when the f items became somewhat more challenging; the rapid learning of the s grouping by the older SG Ss; the gradual steady improvement of the younger SG Ss throughout the course of the training. Figure II, which traces the course of f responses over the training, documents the rapid fall of f responses for both age groups in the SG condition, the persistent tendency of the younger SG Ss to make somewhat more f responses; the steadily high responses of FG Ss throughout the training. Figure III, which traces the o responses, reveals the lack of appeal of the o method for either group as well as the initial experimentation with it by the members of the SG.

Effect of Instruction Change: The Second Post-Test.

The question of whether individuals trained to sort paintings on one basis also have the potential to sort by the opposite criterion was investigated in the second post-test. A series of non-independent two-factor repeated-measures analyses of variance, with age as the between-subject variable and test-form (post-test 1 vs. post-test 2) as the within-subject variable yielded the following findings.

s responses: The number of s responses given by the style-trained group on the second post-test was significantly lower ($F = 98.55$, $df = 1, 22$, $p < .01$); the number of s responses given by the figure-trained group was significantly higher ($F = 238.47$, $df = 1, 22$, $p < .01$).

f responses: The number of f responses given by the style-trained group on the second post-test was significantly higher ($F = 139.13$, $df = 1, 22$, $p < .01$); the number of f responses given by the figure-trained group on the second post-test was significantly lower ($F = 904.77$, $df = 1, 22$, $p < .01$).

o responses: The number of o responses given by the style-trained group did not change significantly ($F < 1$, $df = 1, 22$ n.s.): the number of o responses given by figure-trained Ss was significantly higher ($F = 55.32$, $df = 1, 22 < .01$). Clearly the figure-trained Ss were more tempted by the anomalous choices when instructions were changed, than were the style-trained subjects, who reverted with relative ease to a figural strategy.

interactions and other effects: The age factor alone was significant in two analyses: the number of s responses by figure-trained Ss ($F = 7.74$, $df = 1, 22$, $p < .02$) and the number of o responses by figure-trained Ss ($F = 6.27$, $df = 1, 22$, $p < .05$). The interaction between age and test was significant or approached significance for the number of f responses by the style-trained Ss ($F = 17.06$, $df = 1, 22$, $p < .01$), the number of o responses given by style-trained Ss ($F = 3.99$, $df = 1, 22$, $p < .07$), the number of s responses given by the figure-trained Ss ($F = 8.06$, $df = 1, 22$, $p < .01$) and the number of o responses given by figure-trained Ss ($F = 5.19$, $df = 1, 22$, $p < .05$). Each of these effects and interactions is consistent with the interpretation that the older Ss attended more carefully to the instructions and to the paintings, thereby furnishing more appropriate responses on each post-test.

To determine whether the younger FG gave significantly more s than o responses on the second post-test, a t-test was performed. The test revealed that the younger FG Ss gave significantly more style responses ($t = 3.41$, 22 df, $p < .01$ two-tailed); hence the possibility that FG Ss were simply suppressing f responses in the second post-test is not supported.

The three figures again help clarify the findings. Figure I documents the dramatic change in style responses after the instructions were changed; Figure II the even more dramatic change in the number of f responses following the instruction change; Figure III the relative stability of o responses except for the younger figure-trained group which gave a relatively large number of o responses on the second post-test.

While the results clearly indicate that older Ss were able to revert from sorting by figure to sorting by style on the second post-test, the performance of the younger Ss merits closer inspection. If one simply compares the number of s responses given by the younger SG on the first post-test (mean 12.08) and by the younger figure-trained group on the second post-test (mean 11.08) no significant difference is found ($t < 1$, 22 df, n.s.). However, when one examines some further indices, a more revealing pattern emerges. The SG gave an average of 1.83 o responses on the first post-test, while the FG gave an average of 7.08 o responses on the second post-test ($t = 5.65$, 22 df, $p < .01$ two-tailed). Furthermore, the SG gave an average of 6.08 f responses on the first post-test, while the FG gave an average of 1.83 f responses on the second post-test ($t = 3.45$, 22, df, $p < .01$). Finally the s responses of the FG on the second post-test tended to cluster around the mean (Variance = 100.91) while the s responses of the SG on the first post-test had a larger variance (202.92) and possessed characteristics of a bimodal distribution (see Figure IV). The bimodal distribution of the SG and the clustering tendency of the FG is strongly demonstrated by the fact that 8 out of 12 of the FG but only 1 out of 12 of the SG gave either 9, 10, or 11 s responses in the relevant post-test ($x^2 = 9.6$, 2 df, $p < .01$).

These results suggest that the SG had a more complex task during the first post-test than had the FG on the second post-test. Members of the SG tended either to have mastered the style sorting or to lack any consistent basis for sorting; hence the large number of f responses and the bimodal distribution on the first post-test, with one peak representing Ss who had learned the s sorting, the other peak representing Ss who were still bewildered by the task. The FG members on the other hand had all mastered the f strategy and hence could reject it in toto; they then could choose simply between the s and o choices and 8 out of 12 of them chose approximately the same number from these two categories.

To have a criterion for style sensitivity stricter than mere improvement, two arbitrary performance levels were defined. Ss classifying 12 or more of the sets by s or f were considered "probably sensitive"; Ss sorting 15 or more of the sets in a consistent manner were considered "definitely sensitive"; (both of these levels have $p < .01$ according to the binomial distribution if the three sortings are considered equally likely; the latter has $p < .02$, even if only two sortings are considered possible). In Table 2 is shown the number of Ss considered sensitive according to these criteria.

Table 2

Number of Subjects Judged Sensitive to Style or Figure on Post-Tests (PT) According to Two Criteria

Probably sensitive to figure

	PT 1	PT 2
Older	12	10
Younger	12	7

Probably sensitive to style

	PT 1	PT 2
Older	10	9
Younger	7	3

Definitely sensitive to figure

	PT 1	PT 2
Older	12	9
Younger	11	6

Definitely sensitive to style

	PT 1	PT 2
Older	8	9
Younger	4	2

Total Number of Subjects Sensitive to Style and Figure Across Both Tests

Probably Sensitive to Style

	Yes	No
Older	19	5
Younger	10	14

Definitely Sensitive to Style

	Yes	No
Older	17	7
Younger	6	18

Probably Sensitive to Figure

	Yes	No
Older	23	1
Younger	20	4

Definitely Sensitive to Figure

	Yes	No
Older	21	3
Younger	17	7

Number of Subjects Able to Revert to Opposite Classificatory Mode

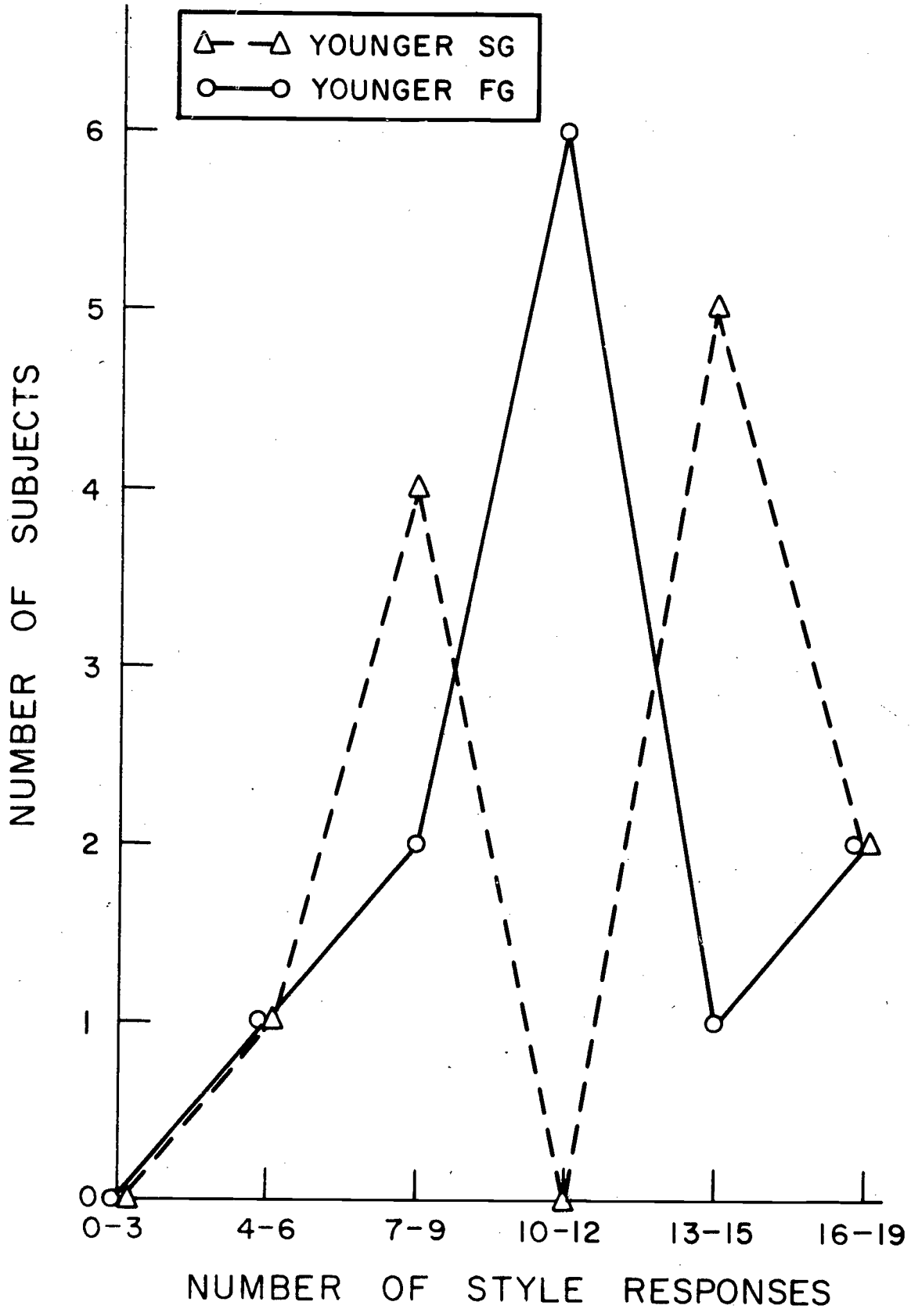
Probable level of sensitivity

	From s to f	From f to s
Older	11	9
Younger	8	3

Definite level of sensitivity

	From s to f	From f to s
Older	9	9
Younger	6	2

Figure IV


YOUNGER SG
YOUNGER FG
NUMBER OF SUBJECTS
0
1
2
3
4
5
6
0-3
4-6
7-9
10-12
13-15
16-19
NUMBER OF STYLE RESPONSES

Chi-squares and binomial probabilities were computed on each of these tables and on all column and row totals of interest derived from them. The following findings were found to be at or near the level of significance: more younger S- (19) are probably sensitive to figure than are probably sensitive to style (10) ($p < .06$, binomial); more younger Ss are definitely sensitive to f (17) than are definitely sensitive to s (6) ($p < .02$, binomial); more Ss at the two age levels are definitely sensitive to f (38) than are definitely sensitive to style (23) ($x^2 = 3.3$, 1 df, $p < .08$); more older (19) than younger Ss (10) are probably sensitive to style ($p < .06$ binomial); more older (17) than younger Ss (6) are definitely sensitive to style ($p < .02$, binomial); more older (9) than younger Ss (3) are able to revert from figure to the probable level of style sensitivity ($p < .06$ binomial); more older (9) than younger (2) Ss are able to revert from figure to the definite level of style sensitivity ($p < .02$ binomial). From a 2 x 2 contingency table included in Table II it was also demonstrated that older Ss are likely to be sensitive to style while younger Ss are more likely not to be sensitive to style (probable level: $X^2 = 5.01$, 2 df, $p < .08$; definite level: $X^2 = 8.35$, 2 df, $p < .025$). These findings confirm the generality of sensitivity to figure as well as the greater style sensitivity and flexibility of the older Ss.

Transfer Tests: Two facets of the transfer tests were of particular interest: the performance of the experimental in contrast to the control Ss and the performance of the FG in contrast to the SG.

Two-factor analyses of variance (age x Condition [Experimental vs. Control]) were separately conducted on four measures: the number of T (texture) responses on the TT; the number of F (Figure) responses on the TT; the number of F responses on the FT; and the number of T responses on the FT. On all four measures the effect of age was significant at the .01 level ($F \geq 13.35$, df = 1, 92), with older Ss always giving more correct and fewer incorrect responses. Only on one measure was there an effect of condition; the experimental group exhibited significantly more tendency to give T responses on the T test ($F = 10.02$, df = 92, $p < .01$). No interactions were significant. Mean scores on the transfer tests are found in Table 3.

Two-factor analyses of variance (Age x Group [FG vs. SG]) were conducted separately using the same four measures on the experimental population alone. Age was significant for each of the tests ($F \geq 5.01$, df = 1, 44, $p < .05$) with the older Ss always giving more correct and fewer incorrect answers. On none of the four tests did the SG and FG show a significant difference in performance. However the number of T responses on the TT given by the SG approached being greater than the number of T responses given by the FG ($F = 3.14$, df = 1, 44, $p < .09$). Because this finding was suggestive, additional analyses were performed.

These auxiliary analyses all suggest that the style training may have resulted in some transfer among the older Ss. The number of texture responses given by the fifth graders in the experimental groups was compared; the SG approached scoring significantly higher than the FG ($t = 1.52$, 22 df, $p < .08$ one tailed); no such trends were found among younger Ss. The number of F responses given by the fifth graders on the TT was also compared and it was found that the FG approached giving more F responses than the SG ($t = 1.37$, 22 df, $p < .10$, one-tailed). The number of F responses given on the FT by the fifth

Table 3

Mean Number of Texture and Figure Responses Given by Experimental and Control Subjects on Transfer Tests

	Texture Test		Figure Test	
	Texture Responses	Figure Responses	Texture Responses	Figure Responses
Younger FG	5.83	7.58	7.83	9.08
Younger SG	7.00	6.58	8.50	8.75
Older FG	8.83	5.75	5.25	11.75
Older SG	11.08	4.75	4.75	13.58
Younger experimentals	6.41	7.08	8.17	8.92
Younger controls	4.83	7.62	7.17	9.75
Older experimentals	9.96	5.25	5.00	12.67
Older controls	7.5	5.45	5.79	11.87
Experimentals	8.18	6.16	6.58	10.8
Controls	6.16	6.54	6.48	10.8

graders was compared and it was found that the SG approached giving more correct answers than the FG ($t = 1.5$, 22 df, $p < .08$, one-tailed). Finally the overall scores on both tests for both age groups were combined and it was shown in a two-way analysis of variance that the age difference was significant ($F = 28.11$, df = 1, 44, $p < .01$) and that the SG approached performing better on the combined transfer tests than the FG ($F = 3.19$, df = 1, 44, $p < .09$).

An analysis of the items on the transfer test was also made. Out of the twenty items on the TT, SG Ss gave more T responses on 13 items, while FG Ss gave more T responses on 4 ($p < .025$, binomial). Of the 20 items, fifth grade SG Ss gave more T responses on 13 items, fifth grade FG Ss on 3 items ($p < .02$ binomial). Of the 20 items on the FT test, SG Ss gave more F responses on 12 items, and FG Ss gave more F responses on 4 items ($p < .04$, binomial). While it would be misleading to attach much significance to these marginal findings, it is possible that the general training involved in stylistic detection enables Ss to look more carefully at pictorial materials generally and therefore improves their scores on both transfer tests, rather than merely improving their scores on one transfer test and lowering their scores on the other.

Latencies: It was hoped that further evidence about the care with which pictures were examined might be obtained from the latency scores. Unfortunately, however, it was discovered after the completion of the study that a factor on which the SG and FG had not been matched was mean latency time; style Ss tended to have longer latencies on the pre-test ($F = 5.16$, df = 1, 44, $p < .05$). Though there is no independent reason to suspect that this asymmetry between the groups influenced other findings, it did preclude a comparison of mean latencies. Evidence that style sorting takes longer than figure sorting does come, however, from a comparison of the latencies on the two post-tests. Of the 24 Ss who had to revert from a figure to a style strategy, latencies of 18 Ss went up and of 6 went down; of the 24 Ss who had to revert from a style to a figural strategy, 8 went up and 16 went down in latency. Chi-square of a 2 x 2 contingency table derived from this data is 6.80, 2 df, $p < .05$).

Controls of the Major Study: As indicated above, the four Ss who were to be shown all sets of paintings without any reinforcement were discontinued when it became evident that the demand was an unreasonable one and that there was no change in sorting strategy. It remains a possibility that sensitivity to style may evolve naturally from looking at paintings, even in the absence of a structured task, but the study provides no confirmation of this possibility. Future studies should include a control group given an innocuous "cover test" unrelated to style perception. Performance of this group on post-tests could indicate whether style sensitivity can be enhanced through participation in a non-directive task.

Operational level: The operational level of each second grader in the study was ascertained by considering performance on four Piagetian tasks. Seven Ss (4 SG and 3 FG) were diagnosed as definitely concrete operational (all responses at level III); eight Ss (4 SG and 4 FG) as definitely at level I (all responses non-operational); the remaining Ss were somewhat in between.

A variety of analyses were attempted in an effort to demonstrate a necessary link between degree of operativity and performance on the test but, with one exception, no link could be shown. For example, one III FG subject went from 19 f sortings on the first post-test to 16 s sortings, but one I FG subject went from 20 f groupings to 17 s sortings. One III SG subject went from 15 s groupings to 6 f and 7 s groupings, while two I SG subjects went from 9 s to 19 f and from 8 s to 17 f respectively. The population was too small to provide statistical support for generalizations, but it appears that it is not difficult to go from s to f even if one is pre-operational; that being operational is helpful in learning style but does not insure the capacity to shift sorting criteria; that Ss between the operational and non-operational level are more successful at learning to sort by style than Ss at the pre-operational level.

The only domain in which a difference which approached statistical significance was found involved performance on the transfer tests. Operational Ss performed significantly better on the two transfer tests than did the non-operational Ss (t on total number correct = 1.99, 13 df, $p < .07$, one-tailed). This finding suggests that general intellectual level was reflected in performance on the transfer tests to a greater extent than in a subject's ability to change the basis of his classification.

Strategies: The comments made by Ss and the strategies employed were not a major focus of the study but the variety of reactions and response patterns were such as to suggest that a separate systematic study should eventually be made of the reasoning involved in learning to classify visual materials in a consistent manner. For this review only three aspects will be commented upon: (1) the characteristic behaviors of the different groups; (2) the erroneous strategies used by Ss; (3) the "solders" or "links" which, while still figural in nature, aided the transition from an f to an s strategy.

1. The FG experienced little disequilibrium throughout the study. Figure was their natural way of grouping and so they were required only to behave consistently. Perhaps half of the older Ss made explicit reference to the fact that there were alternative ways of classifying and a smaller number actually tried a style strategy "for the fun of it" at various points. These Ss had little difficulty in switching the classification criterion for, in a sense, they had been aware of the alternative possibility throughout the training. On the other hand some of the younger FG Ss behaved as though they believed theirs was the only possible way of classifying.

The older SG Ss, with few exceptions, soon realized that figural grouping was never rewarded and so began to search for another basis of classifying. Some Ss knew immediately that the manner of representation was the crucial variable and, by the third week, most of those who would eventually learn to sort by style had already done so. Many of the younger Ss, on the other hand, were shocked to learn the second week that they were not grouping correctly; some expressed disbelief when shown the correct grouping. For the most part, they then proceeded to try out a series of alternative rationales which will be reviewed below. A few of the brightest Ss discovered relatively early that "background..brush strokes..textures..a combination" were important considerstions, but most Ss continued to search for a more familiar explanation.

A number hit upon "solders"--correlated hypotheses (Dulany, 1961) which, though not completely isomorphic with the correct hypothesis, significantly improved their performances, by aiding the transition from figure to style. Eventually these Ss came to realize that the correct pairing involved pictures which "looked the same but aren't pictures of the same thing" or which "feel the same". A fair number of the younger Ss, however, never discovered a consistent basis for grouping and continued changing their criteria from one set to the next. Indeed some of the style Ss did particularly poorly on the post-test because, in the absence of feedback, they forgot the unacceptability of figural responses or continued to try out new hypotheses. Learning not to sort by figure was clearly an important step in mastering the task; but a number of Ss in the psot-tests divided their answers evenly between s and o sortings, thereby revealing that positive as well as negative learning was needed if one were to become sensitive to style.

2. The plethora of erroneous strategies adopted was striking; only the more frequent ones can be mentioned here. Position habits were very popular at the beginning; Ss would stay with a win and move with an error. Others remained in the same position irrespective of reinforcement and one subject systematically avoided a certain positional grouping. Color and size of reproduction were popular strategies, despite the fact that they were rewarded only irregularly. The sex of the figure, "inside" vs. "outside" scenes, dark vs. light, empty vs. full, familiar vs. unfamiliar, pretty colors, good and bad pictures were among the other criteria frequently cited by the SG Ss.

Four strategies consistently plagued certain Ss. Some insisted on relating pictures by some kind of a story; this thematic tack was unprofitable. A number of Ss seemed to assume that religious pictures (Christ or the Madonna) belonged together; others assumed that one picture was part of or embedded in another. Finally a few of the Ss had great difficulty in placing nudes in different piles; nudity was perhaps the strongest figural clue possible.

3. Those Ss who did not immediately perceive that style or texture was wanted sometimes hit upon an intermediate concept (a solder or correlated hypothesis) which proved a reasonably successful criterion on which to base their responses. The most popular strategy (which Walk et al. [1970] exploited in one study) was to think of the pictures as belonging to a family. This approach had two variants: either the pictures were treated as having the kinds of resemblances which families of different sorts have or the subject explicitly suggested that a man and a woman or a mother and a child looked like they were related. A somewhat more sophisticated variant dealt with possible relations between the subject matter in pictures: "these flowers look like they belong to that man" or "he comes from that country." It is probable that Ss using this strategy were attending to relevant perceptual variables and using these expressions as metaphors for stylistic or textural similarities.

Another productive approach involved postulation of an appropriate setting. Ss suggested that a certain picture would look in place in a church, a subway, a book their parents had, or certain kinds of movies or television shows. Since paintings of specific artists and schools do tend to appear in

different settings, this strategy was successful a fair number of times and was seldom misleading.

A final "solder" involved the selection of adjectives which reflected either the circumstances under which or the technique by which pictures had been made. Ss found it useful to think of the pictures in terms of their vintage (that's from the olden-times; that's real modern; that's Chinese) or in terms of the qualities of the distribution of the pigments on the pictorial surface (smooth, bumpy, drippy, smeary, thick, wet, light, etc.). One child concluded, "It's all background"; another said, "It's the way the brushstrokes are made." These approaches focussed more directly on those aspects germane for stylistic and textural aspects: the occasion of their production and the overall impact of the painted surface. Ss who consistently viewed pictures in terms of these variables were generally successful on the task.

Though individual behavior patterns varies widely, younger Ss often found it profitable to move the pictures around and to ponder the various ways in which similarities could be judged. One bright second-grader commented: "There are thousands and thousands of ways to match them." Conversely younger Ss whose eyes moved seldom, who paid more attention to the experimenter than to the pictures, who did not ponder the corrections and did not actively involve themselves in the task made the least progress during the training period.

CHAPTER 4

Discussion

The results leave little doubt that pre-adolescents are able to sort paintings consistently by style. At both age groups there were dramatic increases among the SG Ss in sorting by style, as well as a strengthening of figural tendencies in the FG. When stricter criteria for sensitivity were applied, most of the fifth graders and over half the second graders were judged sensitive and even with the most stringent criterion, 2/3 of the older group and 1/3 of the younger group showed style sensitivity on the first post-test. Clearly the training procedure was effective at both levels, with positive learning of style as well as rejection of the figural approach characterizing the majority of Ss.

It had been thought that members of the SG would experience relatively less difficulty in reverting to their "natural" figural tendency on the second post-test, while FG Ss would have difficulty in adopting the style strategy. But older figure-trained Ss were able to switch to the style strategy nearly as effectively as their peers in the SG were able to adopt the f strategy. Either the older Ss already knew how to sort by style or they were exhibiting learning which was latent during the course of the figural training. So the results indicate that age (or developmental stage) was as powerful a factor as training condition. At the lower age level, as indicated by the age factor and by the significant interactions, Ss in both training conditions experienced some difficulty in adopting the opposite strategy, but for the younger Ss at least, there was support for the hypothesis that it was easier to shift to a figural than to a stylistic strategy.

While the number of s responses given by the younger SG Ss on the first post-test was not significantly greater than the number given by the younger figure-trained Ss on the second post-test, the difference in clustering and distribution is worth stressing. The results suggest that the majority of younger figure-trained Ss did not sort consistently by style but were able to reject the f sorting completely and thus divide their responses fairly evenly between s and o responses. The SG Ss, on the other hand, tended to fall into one of two groups; either they exhibited a clear favoring of the style strategy, developed over the course of the training; or they continued to flounder among competing hypotheses and displayed no consistent behavior whatever. One may conclude that most older Ss can sort by style, irrespective of particular training group, while most younger Ss are only likely to exhibit style sensitivity if subjected to a fairly intensive training regime.

At least two possibilities can account for the superior ease and flexibility of older Ss. Perhaps most older Ss had the capacity to sort the paintings either way from the beginning of the training period and were simply sorting in whichever way was reinforced. Though this explanation seems legitimate for some, it clearly does not apply to those Ss who never learned to sort consistently by style, nor to those who experienced a slow steady rise in performance. Therefore, one must at least entertain another possibility: that both FG and SG Ss were not only learning the approved way of sorting but were also considering alternative arrangements and "latently" learning them during training.

An assumption of latent learning of the figural strategy is unnecessary since Ss demonstrated their mastery of this approach in the pre-test. Evidence in favor of latent learning of the style approach by the figure-trained group comes from two sources: the experimentation during training with "another way of grouping" (which some subjects reported as a new discovery); the fact that the figure-trained Ss performed as well as the SG when asked to sort by style on the appropriate post-test (and better than the SG had performed when first reinforced for sorting by style). Unambiguous evidence in favor of latent learning by the figure group could only be obtained if another control group had seen all the pictures but had been given a totally unrelated task to perform. Regrettably, such a group was not run. For the present, then, it seems most reasonable to assume that both explanations of the stylistic sorting by the older figure-trained group have some validity. Even at the start of the training, Ss had some capacity to sort in both ways, and their flexibility at sorting was enhanced by the eight weeks of looking at pictures in at least some systematic way. Presumably, the older Ss had more spare processing capacity than the younger Ss and thus were able to exhibit greater breadth of learning during the training sessions.

While prior knowledge of both sorting routines is plausible for the older Ss, there is little reason to assume that such knowledge characterized younger Ss. Rather the steady rise in the learning curve for individual Ss and for the group as a whole suggests that Ss in the SG were considering a variety of hypotheses and only gradually concluding that stylistic or textural aspects were relevant to the task. As this task was a time-consuming one, it is not surprising that few of the FG Ss were able to adopt a consistent style strategy in the second post-test; there simply was not time to ferret out the appropriate variable. Hence the large number of o responses by the figure group Ss who were asked to switch strategy and the significant number of FG Ss who have equal numbers of o and s responses on the post-test. The inability of certain style Ss to revert to the figural strategy of the first session has several possible interpretations: the style Ss may have learned to look differently at pictures and so were no longer struck by figural aspects; they may have been confused by the sudden shift in instructions; they may have felt that the experimenters did not desire an obvious solution. While it is most appealing theoretically to claim that the SG Ss were no longer sensitive to figural aspects, there is insufficient evidence to choose between these interpretations.

To supplement the account of the various strategies adopted by Ss, a description of the steps necessary for learning to sort by style will be proposed. It seems essential at the outset that Ss realize the material within the border of the picture, rather than some accidental factor like location or size, must be examined before each sorting. Though most older Ss assumed that the painting per se was the relevant variable, a surprisingly large number of younger Ss resisted examining the paintings themselves with care. Having determined that cues rested within the stimulus, it was also important to eliminate the most obvious figural aspects from consideration. Ss could then either focus on less obvious figural aspects-- like small details-- or eliminate figural aspects altogether and focus instead on color, compositional balance, or materials. Since most young Ss have a strong figural tendency, they frequently continued to construe the task in figural terms, though of a less obvious sort. The various "solders" were helpful since, while somewhat figural in nature, they were not misleading and helped Ss to focus on more

relevant factors such as the way the figures were represented and the overall Gestalt of the work.

In addition to the ability to decenter from the most evident figural aspects, general flexibility, imaginativeness, and ability to benefit from feedback were the most useful capacities. Ss who attended to the E's resorting, kept track of their own hypotheses, were able to consider different facets of the picture, and to appreciate the multiple possible combinations of paintings were more likely to improve on the tasks than Ss who ignored the feedback, adhered to one or two strategies, and refrained from actively manipulating the pictures on the table or in their minds.

Eventually, however, it was necessary for an S who wanted to "solve" the task to realize that the relevant properties of the work were its background, texture, expressiveness, or manner of representation. This realization did not have to be conscious; several of the descriptions such as "rough/smooth" or "ancient/modern" may have been the S's way of identifying style or texture for himself. Nonetheless, even an unconscious realization of what was wanted required a 'revolution' for Ss accustomed to think of pictorial representations in terms of their figural aspects. Though the study provides no direct evidence on how this new conceptualization may come about, it is proposed below that no single factor produces style sensitivity: rather, the development of operational thought and the evolution of Gestalt perception would appear to make the most important contributions.

The findings on the transfer tests were less conclusive than those on the painting post-tests. In view of the marginal results obtained, it is most parsimonious to reserve judgment; but if this caveat is borne in mind, some further comments may be permissible.

The only evidence that the particular treatments had any effect was the strong performance of the fifth grade Ss trained to sort by style. This group appeared to perform significantly better on the TT and also to perform with considerable skill on the FT. This performance could be due to chance conditions, such as the accidental inclusion of a somewhat brighter population in the SG; but it is more likely that the intensive practice these Ss had in looking carefully at pictures may have resulted in heightened discriminatory powers and thus in a stronger performance on both transfer tests.

Why, then, did not the second grade SG Ss show superiority on the transfer tasks over the second grade FG? Two explanations seem possible: either the younger Ss were sufficiently bewildered by the new task so that their major effort had to be exerted in comprehending the instructions, rather than in drawing on recent perceptual acquisitions; or much of their training had been a matter of "identifying" the correct strategy rather than "completely mastering" it, and so lesser transfer could be anticipated. This latter explanation, which is intuitively more convincing, could be tested by having a longer and more intensive training period.

The absence of strong transfer effects should not be taken as a sign that no transfer occurred. It should be noted that the transfer tests were presented to the subjects as if they had no relation to the earlier study and that the instructions for the transfer tests were different than those used previously. Transfer would more likely have been found if the continuity between

the tasks were stressed, the tasks were more closely related, the same instructions were used, and a savings paradigm had been instituted after the conclusion of the study. Of course such transfer would have been of lesser interest and significance than that sought in the present investigation.

One goal of the study was to obtain some evidence on the utility of the notions of texture and figure as components of pictorial arrays which influence Ss' performances. The transfer found in the TT and the superior ability of younger Ss to revert to f as opposed to s strategies on the posttest provides some evidence that figure and texture are not merely products of a psychologist's imagination. What the results also suggest, however, is that texture and figure are not dichotomous or hierarchically arranged variables but rather ends of a continuum to which all Ss are in some degree sensitive. Supporting evidence for this conclusion comes from the erroneous choices made on the two transfer tests: younger Ss gave significantly more F responses on the TT and significantly more T responses on the FT test. These distributions indicate that it should be possible to control whether Ss will direct more of their attention to figural or textural cues, depending on the extent to which each is highlighted. An analysis of specific items on the painting test lends further support for this position.

Though Ss at both age levels exhibited increased ability to use the less accessible category of texture/style in their sortings, they already had developed in the past a strong tendency to approach pictorial displays with attention to their figural properties. Accordingly, relatively less learning appears to have taken place among the FG Ss and so they performed no better than the SG Ss on the FT. It was perhaps too optimistic to expect that a tendency stressed by the culture throughout development can be noticeably enhanced simply through seven additional weeks of practice. While the training sessions did give the older Ss an opportunity to examine pictures at greater length than they may have done in the past, and therefore to appreciate stylistic as well as figural properties, there is no strong evidence that appreciable learning took place in the figure group at either age; they had already known about figure when the study began. Transfer appears to be the most pronounced when one has recently consolidated some knowledge, rather than when one is still in the process of learning the skill or when one has already mastered it at some distant time in the past. It is worth noting, finally, the superior performance of the experimental Ss (as compared to the controls) on the TT. This finding lends additional support to the contention that considerable practice in looking at pictures increases sensitivity to the less salient aspects of visual displays.

The role of intelligence or developmental level in the kinds of sensitivity under examination deserves comment. It had been hypothesized that style sensitivity was closely tied to operational level (Machotka, 1966; Frechtling and Davidson, 1970), requiring either the hypothetico-deductive approach of formal operations or the ability to perform multiple classifications diagnostic of concrete operations. The present results appear incompatible with the requirement of formal operations and also call into question the necessity for concrete operations. The fact that some Ss diagnosed as concrete never learned to classify by style, while others who were preoperational or only on the verge of concrete operations were able to sort by style leads to the conclusion that concrete operations are neither necessary nor sufficient for style sensitivity.

Having made this point, it is only fair to concede that the approach allowed by concrete operations is of help to Ss. It was shown above that operational Ss surpass nonoperational Ss on the transfer tests; the evidence also suggests that this group learns style sorting more rapidly and more readily shifts strategies. This flexibility is to be expected, since concrete operations allow a subject to consider various bases for grouping and to group the same items in more than one consistent way. The ability to anticipate, reverse, isolate, and systematically manipulate variables implied by operational thought doubtless contributes to a ready mastery of the concept of style, as is shown by the relative ease with which the fifth graders mastered the task.

If style sensitivity cannot simply be equated with operational thought, what additional psychological processes seem relevant? The answer can perhaps be suggested by imagining an environment in which figural-contour aspects were relatively unimportant, but qualities of texture and miscrostructure were of moment for survival. There seems little doubt that, in such a "rug-factory world," young children would learn to attend to textural aspects and would show the same tendency to focus on them that children in our environment manifest toward figural aspects. Lorenz (1966) has proposed that the capacity to focus on the relevant or essential attributes of environments or stimuli is a component of the perceptual mechanisms of higher animals and has been developed to a remarkable degree in man. He contends that this "Gestalt perception"-- the capacity to ferret out the relationships among principal elements in a configuration-- is akin to the other kinds of constancies, such as shape or size; as evidence for the strength of this ability, he cites cases in which preschool children are able to make extremely fine discriminations between species, materials, or machines, because they have learned which features are essential for identification (cf. Gardner, 1971a).

Given that such a capacity, though little understood, exists in children, it seems evident that children as well as adults should be able to learn to recognize the works of specific artists. Dürer, Matisse, Bach, or Dr. Seuss would then simply be salient figures, defined by the dominant texture recurrent in their works. It also appears reasonable that a general sensitivity to textural aspects can be developed, given sufficient exposure to a variety of textures and sufficient indication by the culture that texture 'matters'. The present findings are consistent with the interpretation that elementary school children are capable of forming Gestalten for certain artists or artistic schools and/or that these children are capable of forming Gestalten of various kinds of texture. Either of these possibilities should allow an effective strategy in the present task.

While Gestalt perception, on the one hand, or general perceptual differentiation on the other (Gibson and Gibson 1955) can be powerful contributors to stylistic sensitivity, the kind of skill used by accomplished connoisseurs to identify artists appears to involve many other skills as well. These practitioners look not only at the textural aspects but also take into account the age of the canvas, the subject matter preferences of the artist, the iconology and historical context of a work. Such knowledge is not accessible to most school children and the ability to utilize it in an integrated way may be restricted to individuals capable of hypothetico-deductive thought. It is possible, then, that if materials used in such studies were deprived of textural cues, Ss would not exhibit sensitivity to style while connoisseurs might

still make accurate classifications. Yet the coincidence of textural and stylistic cues in most cases is strong enough that a conception of style which excludes aspects of texture appears ill-motivated.

These considerations suggest, then, that style detection is as much a product of the careful attention to recurrent regularities (i.e., textures) which belongs to Gestalt perception as it is a product of the ability to classify consistently across multiple dimensions which belongs to concrete operations. In requiring an S to classify by style or texture, one is asking him to classify in one way; accordingly, his ability to shift classificatory bases is not at issue, except insofar as he must suppress a previously dominant mode of classification.

The findings of the present study supplement in instructive ways those of previous studies on sensitivity to style. The suggestions of Frechtling and Davidson (1970) and the earlier suggestions in the work of Walk et al. (1970) and Gardner (passim) that pre-adolescents might be sensitive to style have received persuasive support. It has been shown that, as in the literary and musical realm, children have a strong tendency to sort works on the basis of salient figural aspects; for the first time it has been demonstrated that a consistent training paradigm can alter the basis on which such children group artistic works. Finally some evidence has been adduced to show that figure and texture represent ends of a continuum, that it is somewhat easier to revert to figural than to stylistic sorting, and that training in attending to the textural aspects of works of art may have manifestations in non-aesthetic realms.

As no exchange of words between experimenter and subject was demanded, questions may be raised as to what was trained in the study. That Ss were merely trained not to focus on the figure is refuted by the finding that the s sorting was overwhelmingly preferred over the o sorting. Yet it remains possible that Ss were sorting on some basis irrelevant to style and that the present procedure could not deal with this possibility.

The advantages of verbal procedures are well illustrated in this objection. Indeed sensitivity to style might well be taught to older Ss using words as well as or even instead of conditioning methods. The present paradigm was selected because of the pilot finding that Ss at the 7 year old level were more confused than enlightened by talk about pictures; reinforcement methods are useful with subject populations for whom verbal interchange is impossible, inconvenient, or unlikely to be effective. It is probable that this circuitous procedure was unnecessary with many older Ss, who might well have learned to sort by style simply through an instruction to that effect. But the two groups had to be treated in a comparable manner if relevant comparisons were to be made.

Despite the lack of emphasis on verbal interchange, the strongest evidence that style/texture was being learned were the incidental comments by the Ss. These comments, only a few of which were noted above, leave no doubt that Ss attempted a variety of univocal strategies, only to abandon them when they were not consistently effective, and that those Ss who eventually learned to sort by style were attending to the right sets of variables, such as background, quality of brushstroke, or manner of representation. Thus in the present study

the possibility that Ss who appeared sensitive to style were answering on other, non-relevant grounds can be rejected.

It is quite likely, on the other hand, that a strategy to the effect-- "Ignore figure and make a general similarity judgment based on a variety of factors or on the general 'feel' of the work"-- would be productive in this task. Far from being an instance of an effective non-stylistic strategy, however, this approach would exemplify the method of style detection as practiced by connoisseurs (Gardner, 1971a); it appears that such a strategy was employed by successful Ss who did not restrict their attention to background or texture.

The study points up some possible problems in the theoretical framework which ordinarily underlies reinforcement paradigms (e.g., Skinner, 1953). While behaviorist theories posit that Ss learn to emit operants for which they have been positively reinforced, and not those for which they have received negative or non-positive reinforcement, the results suggest that older Ss were mastering a strategy during the course of the training for which they were not being reinforced. Any claim that there was reinforcement in the latent learning case must take account of the facts that no reinforcement was planned and no reinforcement was perceptible: indeed, reinforcement had to be imagined to fit the learning that occurred. The present findings, coupled with many others, point up the need for a learning theory which accounts for learning through observation in the absence of a reinforcer, and conceives of individuals as being motivated by more general non-drive factors such as competence in intellectual matters (e.g., White, 1959).

In addition, the inability of non-verbal paradigms to get directly at capacities is a difficult problem for those working in the learning theory or operant traditions and for those outside the tradition who still wish to employ these methods. How does one know that a pigeon who acts as if he is sorting pictures by style, or as if he has a concept of a human, or as if he can do the propositional calculus really has these skills, unless one can ask him directly and probe his response? Considerations of induction indicate that a conclusive demonstration is never possible; one may always find out that some other cue-- ranging from experimenter bias to the physical construction of the reinforcing apparatus-- was controlling the S's behavior. The most the experimenter can do is to select his examples from as wide and representative a range as possible; to use the sets on a control population which can later verbalize the reasons for its behavior; to set high criteria for success; and to hope that other investigators will test the same hypotheses using different Ss and different materials. In the present study every effort has been made to realize the first three conditions: it is hoped that in the future the last one will be fulfilled as well.

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PROJECT ZERO

Harvard Project Zero is a basic research program at the Harvard Graduate School of Education investigating creation and comprehension in the arts and means toward better arts education. Four years ago, Project Zero commenced its search for communicable general principles that could provide some guidance in the design and evaluation of programs for artist and audience education. Such principles, we felt, should be based on a fundamental study of the nature of human abilities important to the various arts, a study investigating relationships of transfer or inhibition among those abilities and seeking means for fostering such abilities. Our effort has involved conceptual analyses, the survey of relevant experimentation and literature in Psychology and other fields, design and sometimes execution of experiments, and visits to institutions engaged in art education.

One starting point of our study was the systematic analysis of types of symbolism and symbol processing in Languages of Art, by Project Director Nelson Goodman, Professor of Philosophy and Research Associate in Education at Harvard University. We have considered such other subjects as the differential impairment of abilities under various types of brain damage, the role of problem solving in artistic endeavor, relations between the psychology of vision and the visual arts, perception of rhythm in music, and style recognition in various media. Though the development of actual curricula in arts education is not a primary concern, the Project does contribute to the field of practical education by responding when possible to requests for consultation and by suggesting needed programs. The Harvard Summer School Institute in Arts Administration was established at the recommendation and with the cooperation of the Project.

The Project sponsors a series of lecture-performances in various media, designed to give the general public and prospective public school teachers and administrators better insight into and attitude toward artists and the arts. As the series title, "Art in the Making" suggests, the purpose of the lecture-demonstrations is to reveal something of the artist's way of working, rather than to display his products. This work with artists in an educational context also brings our theoretical research into constant contact with practical and artistic realities.

PROJECT ZERO TECHNICAL REPORTS

1. Vernon A. Howard, Harvard Project Zero: A Fresh Look at Art Education
2. Barbara Leondar, The Arts in Alternative Schools: Some Observations
3. Howard E. Gardner, The Development of Sensitivity to Figural and Stylistic Aspects of Paintings

The following reports are forthcoming:

4. Howard E. Gardner, Children's Sensitivity to Musical Styles
   Children's Sensitivity to Painting Styles
   Children's Literary Skills
5. David Perkins, Cubic Corners
   The Perception of Line Drawings of Simple Space Forms
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