The copying of geometric figures is a method that is used in many tests that measure visuomotor development (Bender, 1938), visuomotor integration (Beery, 1967), visual perception (Ayres, 1972; Frostig, 1966), constructional praxis (Baum & Hall, 1981; Benton, 1967; Farver & Farver, 1982; Goodglass & Kaplan, 1972), and personality (Weininger, 1987). The effect that different types of figures may have on test performance, however, is rarely addressed in the use of such measures. Specifically, do figures that represent meaningful or familiar objects result in better test performances than nonrepresentational figures?

Gibson (1929) found that a subject's reproductions of stimulus figures often reflect the subject's comments on those figures. If a figure reminds the subject of an object, the subject's drawing tends to be more like the familiar object than like the stimulus figure. In a similar experiment, Carmichael, Hogan, and Walter (1932) paired ambiguous figures with a word or verbal description of the figure. Their results showed that the recall of a visually perceived form was often altered by the word it was paired with.

Goldstein and Sheerer (1941) used a stick construction test to demonstrate differences in perception between non-brain-damaged and brain-damaged adults. In their test, they distinguished between abstract (nonrepresentational) and concrete (representational) figures. They illustrated how one patient was able to reproduce a seemingly more complex representational figure, but was unable to reproduce a seemingly simpler nonrepresentational figure. The patient was unable to reproduce the position of a stick pointing from lower left to upper right or an angle of two sticks pointing downward. "That's nothing" was the patient's response to the figures. He was inconsistent, however, in his reproduction of a design that resembled a house containing nine sticks. Somehow the activity (occupation) of reproducing the representational figure of a house was different from that of reproducing the nonrepresentational figures.

The geometric complexity of a figure is not the only factor responsible for failures or errors in its reproduction. A complex geometric design that is nonrepresentational may challenge our ability to reproduce it, but a design of similar complexity that is representational is easier to reproduce (Goldstein & Sheerer, 1941).

One possible explanation for this decreased demand on our design reproduction abilities is that the representational figure provides cues for our performance. A representational figure comprises elements common to some known object. These elements, or invariants as Gibson (1986) referred to them, provide cues as to the shape and dimensions of the form. The invariants of a house may be a pointed roof, walls
perpendicular to a base, and a rectangular door. With these cues, the task of drawing the figure no longer requires the person to conceptualize abstract relationships between the elements of the figure. Instead, the relationships are predetermined by the invariants of the known object (e.g., the house).

The use of representational forms is significant from a perceptual learning standpoint. Luria (1948/1963) used a common Russian word when working with a brain-injured patient to restore the perceptual-motor process of drawing an irregular sawtooth pattern. The patient was unable to reproduce the pattern until it was suggested to him that it represented a word. Luria called this process conceptual reconstruction.

Ball (1971) suggested a method by which representational figures could be used in perceptual training. Using Goldstein and Sheerer's (1941) example of the patient who could reproduce a house from sticks but not nonrepresentational figures of one or two sticks, Ball suggested replacing the sticks of the lower part of the house with solid black lines, leaving only the roof to be completed with two sticks. As the patient succeeds in making roofs of varying pointedness, the lines representing the balance of the house can be faded until the patient is left with only the two roof sticks representing an abstract relationship. Assuming that generalization occurs, the patient will have reacquired the ability to deal with objects abstractly.

Perceptual-motor and constructional praxis impairments are common problems in patients with head injury or cerebrovascular accident (Baum & Hall, 1981). Age-related changes may also produce signs of perceptual-motor impairment (Farver & Farver, 1982). Design copy tests are often used to assess these deficits (Baum & Hall, 1981; Benton, 1967; Farver & Farver, 1982; Goodglass & Kaplan, 1972).

Although Goldstein and Sheerer (1941) and Luria (1948/1963) have cited case studies showing a relationship between a brain-damaged person's verbal report of perceived meaning in a given figure and his or her ability to reproduce that figure, the literature reveals no controlled experimental study of this phenomenon. Gibson (1929) reported a tendency for non-brain-damaged subjects to alter their reproductions to resemble familiar objects, and Carmichael et al. (1932) found paired words to influence the reproductions. These studies did not, however, compare representational and nonrepresentational forms.

Nelson (1988) proposed the use of the terms occupational form and occupational performance to define occupation. According to Nelson, "occupational form is the preexisting structure that elicits, guides, or structures subsequent human performance; occupational performance consists of the human actions taken in response to an occupational form" (p. 633). The therapist can alter the occupational form to alter the occupational performance. A person will ascribe different meanings to different occupational forms. These meanings lead to a sense of purpose (the person's goal orientation), which guides the occupational performance.

Nelson's (1988) terminology provides a conceptual framework from which we can analyze the consequences of the patients in Goldstein and Sheerer's 1941 study. According to Nelson's terminology, different occupational forms (stick figures) had different meanings for the patients (representational versus nonrepresentational). The added meanings and purposes of the representational forms resulted in enhanced occupational performances. The subjects' performances were then measured by their impact on the environment (i.e., their success or failure in reproducing the forms). Goldstein and Sheerer also stated that one cannot always predict whether a person will respond to a particular task in a concrete manner, based on the configuration of the form. This is also consistent with Nelson's assertion that occupational form does not predict occupational performance.

Added purpose and added meaning have been the basis of occupational therapy since its beginning (Mosey, 1981). The effectiveness of added purpose activity (occupation) to enhance performance in exercise-type activities has been demonstrated for positive response and duration of performance (Miller & Nelson, 1987; Yoder, Nelson, & Smith, 1989), heart rate at a specified level of exertion (Bloch, Smith, & Nelson, 1989; Kircher, 1984), and number of repetitions (Steinbeck, 1986). These studies have demonstrated that added purpose (through added meaning) does enhance performance in selected types of exercise. The present study further investigated the effects of added meaning in occupations through a comparison of the effects of representational figures and nonrepresentational figures on performance on a design copy task. We hypothesized that representational figures would result in better performance on the task than would nonrepresentational figures.

Method

Sample

Thirty-four subjects were selected from six midwestern nursing homes. Four of the subjects were dropped from the data analysis due to failure to complete the task or failure to name the three representational drawings (see the Procedure section). The subjects had to meet the following selection criteria:

1. Ability to draw with a pen.
2. Functional vision.
3. Functional hearing.
4. Ability to follow the instructions of the task.
5. At least 60 years of age.
6. No history of neurological disease or injury.

These criteria were assessed through performance on the two sample test items described in the Procedure section (Criteria 1 through 4) and by the verbal report of staff members (Criteria 5 and 6). The Parachek Geriatric Rating Scale (Parachek & King, 1986) was administered to better describe the sample.

Twenty-two women and 8 men participated in the study. The subjects' ages ranged from 67 to 92 years, with a mean age of 82.9 years ($SD = 6.8$). The scores on the Parachek scale ranged from 33 to 50 points, with a mean score of 39.7 ($SD = 4.3$). Parachek and King (1986) described persons scoring between 25 and 39 points on this scale as being responsive, able to interact to some degree, and able to participate somewhat in their own care. Persons scoring between 40 and 50 points are described as being able to manage most self-care activities and likely to be self-motivated.

Instrument

The assessment instrument consisted of six line drawings, each on the top half of an 8½ in. by 11 in. piece of paper. On the bottom half of each paper were starter lines that corresponded to certain lines in the stimulus figure at the top of the paper (see Figure 1). From these lines, the subjects were asked to complete a drawing that looked like the stimulus figure. The function of these starter lines was to ensure that the subject's drawing was cued to be on the same scale as the stimulus figure.

Three of the figures represented objects assumed to be familiar to the subjects—an arrow, a house, and

![Figure 1. Stimulus figures (located on the top half of each sheet of paper) and starter lines (located on the bottom half of each sheet of paper) used in the design copy task. The actual drawings were presented on 8½ in. by 11 in. paper. Figures 1a, 2a, and 3a are representational; Figures 1b, 2b, and 3b are nonrepresnetational. The two orders of presentation were 1a, 1b, 2a, 2b, 3a, 3b (Order 1) and 1b, 1a, 2b, 2a, 3b, 3a (Order 2).](image-url)
a face (see Figure 1). The other three figures were made of the same geometric shapes and positioned in the same locations on the paper as the representational figures. The shapes, however, were combined differently. For example, the curved line that represents the mouth of the face, the triangle that represents the head of the arrow, and the rectangle that represents the walls of the house were combined to make one figure. In this way, we could use three nonrepresentational figures for the control condition that were equal in complexity to the three representational figures in the experimental condition. Together, the three nonrepresentational figures were equivalent to the three representational figures.

Measurement
All of the drawings were scored by a rater who was unaware of the hypothesis being tested. The subjects' drawings were measured for accuracy with transparent graphs that had the ideal lines for the drawings on them. For the straight lines, rectangular graph paper with 5 squares per centimeter (2-mm squares) was used. For each circle, a circular graph was used. The circular graph contained one circle the size of an ideal circle with concentric circles inside and outside of this ideal circle decreasing or increasing in diameter by increments of 2 mm. Radii were drawn through these circles such that they intersected the ideal circle at 2-mm increments along its circumference.

When these graphs were overlaid on a subject's drawing relative to the starter lines, the rater could measure how much the drawing varied from the stimulus figure. The rater scored each line of a drawing by counting how many squares the drawn line was from the ideal line, as well as by counting the total number of squares that the drawn line passed through. For example, if the ideal line was vertical and 5 squares (10 mm) long, and if the subject drew a line 5 squares long but 1½ squares (3 mm) off to the side of and parallel to the ideal line, the score would be 10 (i.e., the line crossed 5 squares and each square was worth 2 points because they were 2 squares off ideal).

Procedure
The subjects were randomly assigned to two different orders in such a way as to ensure proportionate representation by sex across the two orders. In Order 1, the subjects were presented with a representational figure first, and in Order 2 the subjects were presented with a nonrepresentational figure first. The subsequent order of presentation for the remaining designs was alternated between representational and nonrepresentational for each subject.

The principal investigator (the first author) conducted all data collection procedures. The subjects were told that the researcher was interested in their drawing abilities. Two trial drawings (one representational and one nonrepresentational) were used to ensure that the subjects understood the task. With the presentation of the first trial drawing, the following instructions were given:

You are to copy the picture from the top half of the paper onto the bottom half of the paper. Some of the lines have already been drawn for you. You will use these lines to help you make your picture. Let's try this one for practice. Make the bottom look just like the top, use these lines to help you. Take as much time as you need.

With the second trial drawing, the instructions were as follows: “Let's try one more for practice before we begin. Copy this drawing onto the bottom half of the paper, starting with the lines provided.”

If the subject was able to complete the two trial drawings, the principal investigator presented the six actual experimental drawings to the subject and asked the subject to draw them by saying, "Now copy this drawing." If necessary, the subject was reminded to draw on the bottom half of the paper and to use the starter lines.

Upon completion of the drawings, the subject was asked to look at the pictures again. A separate set of stimulus figures was used for this to avoid confusion with the subject's own drawings. The two figures used for the trial drawings were placed in front of the subject first, and the principal investigator said, "Of these two pictures, some people find one easier to give a name to than the other." The principal investigator then named the one figure a tree. After this, the remaining stimulus figures were placed in front of the subject, and the researcher said, "Now look at these six pictures. Some people find three of these easy to name. Could you name the three pictures that you find easiest to name?"

We assumed that the subjects would perceive an arrow, a house, and a face in three of the pictures and only geometric shapes in the other three pictures. If this assumption did not hold true for a subject (e.g., if a subject failed to note a meaningful object in a representational figure or noted something other than a geometric shape in a nonrepresentational figure), that subject's data were dropped from the study. Three of the 4 subjects dropped from the study were dropped because of a failure to name all of the representational figures; 2 failed to name the arrow, and 1 was unable to name any of the pictures.

In general, the arrow tended to be the most difficult for all of the subjects to name. Names given for the representational pictures other than arrow, house, and face included shed (3 subjects); school (1); barn (3); doghouse (1); moon (8); pumpkin, jack-o-lantern, or halloween face (7); smiley face (1); and one-way sign (1).
Data Analysis

We obtained a composite score for each condition by combining the scores of the three drawings in each condition. All assumptions were met for the use of an analysis of variance with a repeated measure. A two-way analysis of variance with one repeated measure was used to analyze the main effects and the interaction of order by type of figure (representational and nonrepresentational).

Interrater Reliability

The principal investigator randomly selected and independently scored 10% of the drawings to establish interrater reliability with the primary rater. Reliability was calculated by the intraclass correlation coefficient (ICC), as recommended by Shrout and Fleiss (1979), for a fixed-effects model (when the two raters are the only ones of interest). The ICC equaled .999, which confirms the objectivity of the scoring procedures.

Results

The results are presented in Tables 1 and 2. Because there was no significant effect for order or for the interaction between order and type of figure, the likelihood of an order effect was ruled out. The scores on the representational drawings were significantly lower ($p < .01$) than the scores on the nonrepresentational drawings. Thus, the hypothesis was upheld that, on a design copy task, representational figures would elicit better performance (fewer errors) than would nonrepresentational figures.

In the picture that represented a face, all but 2 of the subjects failed to correctly use the starter line for the mouth. The subjects who used this line incorrectly tended to use it as part of the large circle representing the head. Because this penalized the subjects in the representational condition, this cannot be the reason for the significant difference found.

Table 1
Descriptive Data for Scores by Type of Figure and Order

<table>
<thead>
<tr>
<th>Order</th>
<th>Type of Figure</th>
<th>Representational</th>
<th>Nonrepresentational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order 1 (n = 15)</td>
<td>M</td>
<td>1236.7</td>
<td>1451.9</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>353.1</td>
<td>537.4</td>
</tr>
<tr>
<td>Order 2 (n = 15)</td>
<td>M</td>
<td>1028.3</td>
<td>1318.7</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>276.9</td>
<td>436.7</td>
</tr>
<tr>
<td>Orders combined</td>
<td>M</td>
<td>1152.5</td>
<td>1385.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>318.1</td>
<td>486.7</td>
</tr>
</tbody>
</table>

Note. Lower scores indicate fewer errors and better designs. Order 1 = representational figures presented first; Order 2 = nonrepresentational figures presented first.

Table 2
Two-Way Analysis of Variance With One Repeated Measure

<table>
<thead>
<tr>
<th>Measure</th>
<th>df</th>
<th>$M^2$</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order</td>
<td>1</td>
<td>437589.6</td>
<td>1.89</td>
<td>.180</td>
</tr>
<tr>
<td>Within cells</td>
<td>28</td>
<td>231642.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Figure</td>
<td>1</td>
<td>958112.1</td>
<td>9.38</td>
<td>.005</td>
</tr>
<tr>
<td>Order X Type of Figure</td>
<td>1</td>
<td>212064</td>
<td>0.21</td>
<td>.652</td>
</tr>
<tr>
<td>Within cells</td>
<td>28</td>
<td>102190.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. All subjects received both the representational and the nonrepresentational types of figures.

Discussion

The results of this study indicate that representational figures did predict better performance on a design copy task for the sample tested. These results lend support to a basic tenet of occupational therapy, that added meaning in activities improves performance. As described in the introduction, previous studies have indicated that added meaning has a positive effect on exercise in selected populations. The present study demonstrates that perceived meaning can also enhance performance in a visuomotor task, at least in an elderly population.

Further study of these principles with other populations is needed. Ball (1971) suggested that representational figures may be useful in retraining perceptual-motor skills in brain-injured patients. The therapist can alter the occupational form of the design copy task to elicit the desired occupational performance of a completed picture. Once the patient can perform the task with a representational form, the invariants of the representational form can be gradually faded until some nonrepresentational form is left and the patient reacquires the ability to work with this nonrepresentational form. Because of the possible implications for brain-injured patients, this study merits duplication with a brain-injured population.

The outcomes of this study are consistent with past studies that point to a relationship between the meaning of a stimulus figure and a subject's reproduction of that figure. The present study appears to be the first controlled experimental study of the effect that added meaning has on performance in design reproduction. We varied the occupational form of the task in a controlled manner and objectively measured the effects on the occupational performance.

The differences between the two conditions may have been even stronger had we been able to determine definitively whether a subject saw a picture as representational while drawing that picture. Perhaps some subjects did not see the pictures as representational while drawing them and saw them as meaningful pictures only after they were asked to name them.
For such subjects, one would not expect to find a difference in performance between the types of figures. To investigate this possibility, the subjects would have to be asked to name the pictures before drawing them. The independent variable, then, would be named pictures versus unnamed pictures. With this procedure, however, some subjects may give a name to a picture only because they think they are supposed to be seeing something in the picture and not because they actually do see a representational figure. For this reason, the subjects in the present study were asked to look at the pictures all at once after drawing them and then to name only three of them.

Additional research is needed to further define the effects of representational figures on design copy tasks. Future studies could be done without the use of starter lines to allow greater variations in the size and position of the figures drawn by the subjects. In this way, one could analyze whether representational figures would result in the reproductions being more accurate in size and location on the paper. Future studies could also include the use of other design copy tasks such as stick or block construction tasks. Further definition of what makes a figure representational to a person may also be needed. Must the picture resemble a familiar object? If so, what parts of the picture are necessary to make it represent that object? For example, is a circle all that is needed to represent a ball?

Conclusion

This study demonstrates the effectiveness of added meaning and subsequent added purpose in a design copy task completed by institutionalized elderly persons. More research is needed to identify the specific factors involved in the use of representational figures for design copy tasks and to generalize these findings to other populations.

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