The Effects of Hands-on Occupation Versus Demonstration on Children’s Recall Memory

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Objective. Hands-on learning has been an important aspect of the profession of occupational therapy since its founding. The purpose of this study was to determine whether children engaged in hands-on learning would be able to recall more of the steps and more of the correct order of the steps of an occupation than children engaged in a demonstration teaching method.

Method. After being randomly assigned, 73 healthy third-graders (42 girls and 31 boys) either participated in making a model of a volcano or observed the making of a model of a volcano. Following task completion, both groups were asked to recall and state as many of the 41 syntactical units as possible in their proper order. The children’s responses were audiotaped and scored in a blind fashion according to predetermined criteria. Interrater reliability was excellent.

Results. A t-test revealed a significant difference between conditions in terms of free recall scores, with children in the hands-on condition having a greater recall score, t (71) = 2.63, p < .005. The effect size d equaled .62. A Mann-Whitney U Test revealed no significant difference between conditions in terms of remembering the steps in proper order (the lack of a significant difference may have been due to a problem of measurement).

Conclusion. The results of this study demonstrated that participants were able to recall more information when engaged in a hands-on teaching method as compared with a demonstration method. It is suggested that the learning advantages of hands-on occupation are related to the enhanced sensory/perceptual experiences and the feelings of success that are characteristic of hands-on learning, as opposed to passive forms of learning.


The eminent American philosopher and educator John Dewey (1916, 1966, p. 202) advocated the use of “active occupations,” including play as well as work, as the best means for promoting learning and education in healthy children and other citizens. Dewey valued active, hands-on occupations that are “carried on for their own sake” (p. 205) as contexts for students to obtain skill and information. Dewey stated that the powers of observation and recollection depend on occupation. Observation leading to learning takes place when the person “has something to do which can be accomplished successfully only through intensive and extensive use of hand and eye” (p. 66). In a learning occupation, “each earlier act prepares the way for later acts, while these take account of and reckon with the results already attained...” (p. 337). Learning is an outcome of the enhanced sensation provided by occupa-
tion, as well as the observed changes wrought in the occupational process. Dewey argued that the occupational approach to learning is superior to the traditional educational method of training the mental faculties through "monotonously uniform exercise" (p. 66).

Dewey's thoughts concerning occupation and learning in healthy citizens influenced the founders of occupational therapy, who were attempting to use active occupations for the betterment of persons with impairments and disabilities. Tracy (1910, p. 13) explicitly cited the philosophy of John Dewey in describing the power of occupation in improving the recovery of hospitalized persons. Later, Slagle (1922) also cited Dewey's ideas as influential to the field of occupational therapy (see also Breines, 1986, for a description of the work relationships between early occupational therapists and associates of Dewey).

From the beginning of the profession of occupational therapy, the benefits of occupation were seen as extending both to the mind and the body (Kidner, 1930; Slagle, 1922). In 1925, a committee of the American Occupational Therapy Association stated that one of the principal psychological aims of occupation used with patients was to improve "concentration of attention" (Dunton, Adams, Carr, & Robinson, 1925). Dunton (1928) was explicit in noting the relationships between occupation and the mental processes of observation, concentration, and memory. Tracy (1910) had called for the use of occupations in the treatment of persons with mental deficiencies, whether developmental or acquired. Therapeutic occupation could simultaneously be an intervention for improving movement, emotional well-being, and the processes of thinking. As Meyer (1922, p. 5) stated, "It is the use that we make of ourselves that gives the ultimate stamp to our every organ."

Given the profession's commitment to occupation as a context for learning, it is ironic that little research can be identified in the occupational therapy literature which directly addresses this issue. In his Eleanor Clarke Slagle lecture, Nelson (1997) recognized this:

“For decades, occupational therapists have used common, everyday occupational forms and hands-on doing to enhance what Dunton (1945, p. 11), one of the founders, called the ‘mental processes of reasoning or judgment or remembering.’ Recently, cognitive researchers, mainly psychologists, have developed a body of knowledge concerning the effects of ‘subject-performed tasks,’ or SPT’s, on human cognition (for example, please see Backman, 1985). The basic idea of SPT’s is that hands-on doing, with its added sensory input and opportunity for feedback, is a greater cognitive stimulant than demonstration or other teaching techniques not involving hands-on experience. The problem is that the cognitive psychologists pursuing this line of research have not cited occupational therapy authors, who have advocated this principle since the beginning of the profession. Our problem here is that we have not done the research necessary to establish our special expertise in the area of hands-on doing, or occupation.”

Nelson (1988, 1994) defined occupation as a special relationship between occupational form and occupational performance. Occupational form is the physical and sociocultural situation external to the person. Depending on the person's developmental structure, an occupational form can become subjectively meaningful for a person. This may lead to a sense of purposefulness and active, voluntary occupational performance. In the very act of doing something with meaning and purpose, the person adapts, or changes. The person also changes the world (impact) (see Figure 1).

Dewey and the early occupational therapists suggested that the opportunity for transforming materials in socioculturally recognizable ways is a key component for learning. We can think of this opportunity as part of the occupational form of an occupation. A therapist or an educator is viewed as an opportunity giver, as opposed to someone who

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**Figure 1. Occupation. Note. Copyright © D. Nelson, 1994. Reprinted with permission.**
impacts information by talking. As the learner pursues the opportunity with meaning and purpose, active occupational performance results in impacts. These products of the changing occupational form provide opportunities for feedback (evolving meanings). Two types of feedback are involved: sensory/perceptual meanings originating potentially in each of the sensory systems, and symbolic meanings involving judgments as to the ongoing success of the occupation. A judgment of sociocultural success is the degree to which the impact matches sociocultural norms, whereas the judgment of personal success is the degree to which the impact matches one’s own purposes (Nelson, 1994).

An occupational form involving the opportunity for transforming materials is theorized to be more meaningful to many people than other kinds of instruction because of the sensory/perceptual and symbolic feedback. As the person transforms materials, tactile and proprioceptive inputs (and sometimes vestibular, olfactory, or gustatory inputs) are experienced in combination with visual and auditory inputs in ways that are not possible when attending a lecture or a demonstration. In addition, it is theorized that the experience of success through one’s own active doing makes the occupation memorable.

Occupational therapists have done little to demonstrate the effects of occupation on verbal learning and memory. An exception is the research by Yuen, Nelson, Peterson, and Dickinson (1994), who studied the learning of a novel motor task. In this study, an occupational form providing feedback to movement was compared with a free-movement condition within the context of mastering an upper extremity training prosthesis. The researchers theorized that the added affordance provided by the feedback was responsible for the superior learning documented in the study.

Those outside the field of occupational therapy who have studied the effects of subject-performed tasks (tasks performed by the individual) include Backman (1985); Karlsson, et al. (1989); Larsson and Ronnberg (1987); Hutton, Sheppard, Rusted, and Ratner (1996); Zimmer and Saathoff (1997), and Vakil, Hoffman, and Myzliek (1998). In general, these studies have found that individuals who engage in subject-performed tasks recall more than those engaged in passive learning. For example, Larsson and Ronnberg (1987) reported that subject-performed tasks elicited considerably higher levels of both immediate and long-term recall than passive learning situations. Vakil, Hoffman, and Myzliek (1998) found that active learning left relatively durable traces in memory, and resulted in an enhanced ability to solve an advanced problem related to the training task.

Only three prior experiments have addressed the issue of active versus passive learning from an occupational therapy perspective. Warner (1989) coined the term “hands-on occupation” as a label that recognized the historical importance of work with the hands within the profession of occupational therapy. Twenty-nine older women with moderate mental impairments were randomly assigned to either a demonstration with a hands-on occupation or a demonstration-only occupation. The demonstration-only group observed the researcher making ice cream, while the hands-on group both observed the researcher and practiced making ice cream. At the end of the occupation, both groups were given a written task-related quiz designed as a measurement of memory retention. The questions were based on information that could have been learned through the occupation in either condition (e.g., Should the ice cream custard be cooked over low, medium, or high flame?) A t-test supported the hypothesis that participants in the hands-on occupation had higher memory retention than participants in the demonstration-only occupation.

Eakman and Nelson (in press) continued this line of research by comparing the effects of hands-on occupation with verbal training on free recall. Thirty men (mean age = 29.6) who had sustained brain injuries were randomly assigned to two experimental conditions. Individuals in the hands-on occupation received step-by-step verbal instructions on how to make meatballs as well as hands-on practice of each step; participants in the verbal training received step-by-step instructions only. After the final step for both groups, participants were asked to recall the steps involved in making meatballs in their proper order. A Mann Whitney U test supported the hypothesis that participants in the hands-on occupation recalled significantly more task steps in their proper order than participants in the verbal occupation.

Buddelmeyer (1995) extended the work of Eakman and Nelson (in press). Sixty children with learning disabilities between the ages of 8 and 13 were randomly assigned in subgroups to either a hands-on occupation or to verbal training. Children in the hands-on occupation received step-by-step verbal instructions on how to make play-doh as well as hands-on practice of each step. Children in the verbal training condition received step-by-step instructions only. After the final step for both groups, the children were asked to recall the steps involved in making play-doh, in their proper order. A t-test supported the hypothesis that children in the hands-on occupation group had higher memory retention than children in the verbal training condition.

Continued studies with children, in the area of hands-on learning, is needed in the occupational therapy profession. Occupational therapists play a critical role in the provision of educational services, and, as authorized by law, their role in the school system is to provide services that are directly related to helping students meet their educational needs (Drummond, 1996; Sarracino & Hanft, 1996). Learning and retaining new information are primary educational needs, and occupational therapists can play an important role in assisting students to meet these needs. One way in which occupational therapists can enhance student learning is by modifying methods of instruction to best match individual learning styles.

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In contrast to previous studies, the current study focuses on children without impairments or disabilities. While one study in occupational therapy focused on children with learning disabilities (Buddelmeyer, 1995), no published study has compared hands-on occupation versus demonstration in terms of healthy children’s verbal recall ability. The participants in the current study were third-grade children between the ages of 7 and 9 years. This age was chosen based on the literature of cognitive development. While recognition memory is well developed by the end of preschool years, recall memory occurs after the development of recognition memory. At approximately 7 years of age, a child progresses to the concrete operations level of cognitive development (Piaget, 1981), when recall memory development begins to occur (Ginsberg & Opper, 1988).

In previous studies of hands-on learning, the dependent variable involved a combination of the number of instructions recalled and the correctness of the order of recall. In the current study, it was decided to treat these two factors as separate dependent variables. It is possible that hands-on learning affects the two variables differently.

In the current study, it was important to select an occupational form that would provide an appealing learning situation to third-grade children. An informal survey of six grade school teachers indicated that school-aged children often found science experiments meaningful and enjoyable. Based on this information and a review of science curriculum literature, the construction of an “erupting volcano” was chosen. Building a model of a volcano was educationally relevant to a science curriculum while providing an opportunity to experience either hands-on learning or passive instruction via demonstration.

Based on occupational therapy principles and prior studies supporting the use of hands-on occupation to enhance learning, two directional hypotheses were made. It was hypothesized that participants engaged in a hands-on teaching method embedded in a meaningful and purposeful occupation would have a greater recall score than participants engaged in a demonstration teaching method. It also was hypothesized that participants who engaged in a hands-on teaching method would recall more task steps in their proper order than participants who engaged in a demonstration teaching method.

Method

Participants

Administrators of five midwestern schools were invited to participate in the study; three expressed interest. Of these three, one was excluded from participation because the children had recently completed a science unit that involved building models of volcanoes. A packet of information including a consent form, a brief description of the study, and a letter of support from school officials was distributed to all children enrolled in the third grade at the two participating schools. Participants were required to be free from developmental disorders, to be between 7 and 9 years of age, and to have no previous experience with making a model of a volcano.

Eighty-three children (39 boys and 44 girls) turned in permission slips and were allowed to participate in the study (60 children from one school and 23 children from the second school). Ten children did not meet the study’s requirements, and although they were allowed to participate in making of the volcano, their results were not included in the data analysis. Eight of the 10 children became ineligible after the testing was underway (i.e., one became sick, one did not want to be recorded, six reported making volcanoes in the past). Testing of the participants occurred over an 8-week period.

Materials

The following materials were used in both the hands-on and the demonstration conditions: 10 lbs. of sand, 9 in. by 11 in. foil roasting pan, small plastic sandbox shovel, 18 oz. aluminum can, empty 18 oz. plastic tumbler, 8 in. plastic spoon, 8 oz. plastic measuring cup, plastic measuring cup (1/4 cup), plastic measuring cup (1/3 cup), 16 oz. box of baking soda, 20 oz. plastic bottle of dishwashing liquid, 20 oz. plastic bottle of white vinegar, 1 oz. plastic bottle of red food coloring, 16 oz. plastic cup filled with lukewarm water, eyedropper, and plastic tablecloth. In both conditions, a digital kitchen timer was used to regulate the allotted response time, and a tape recorder and cassette tape were used to record participant recall.

Procedure

Informed consent was obtained from all participants and their parents or legal guardians before they were allowed to participate. Students were randomly assigned to the hands-on condition \((n = 42)\) or the demonstration condition \((n = 41)\). Each participant was seen individually by the researcher. In both conditions, the participant was seated at a table, directly across from the investigator. Participants in the demonstration condition observed the investigator making a model of a volcano, while participants in the hands-on condition made a model of a volcano by themselves (the investigator did not make a volcano in the hands-on condition). Immediately before each of the 11 steps in making the volcano (see Appendix), the investigator read aloud the instructions printed on a 5 in. by 7 in. note card. Participants verbally repeated each instruction within five sec before proceeding. Both the investigator in the demonstration condition and the participants in the hands-on condition had 30 sec to complete each step, which proved adequate. Each condition lasted approximately 15 min.

In both conditions, the materials were kept out of sight until they were needed. Once materials were used and were no longer needed, they were removed from view.
Following both conditions, the investigator asked three distractor questions to divert participants from rehearsing the steps. Next, each participant was given an opportunity to be excused if he or she did not want to be tape recorded. If the participant agreed to be tape recorded, he or she was asked to state the exact steps involved in making the volcano. None of the students exceeded the 210 sec allotted for a response. If the participant indicated that he or she could not remember any more steps, recording was stopped. If the participant was silent for 10 sec, the participant was instructed to try to remember the steps. If the participant remained silent for an additional 10 sec, the participant was asked if he or she could remember any more steps. If the participant responded no, the recording ended. If the participant responded yes, he or she was prompted to tell them. If the participant failed to respond to this verbal prompt within 10 sec the recording ended. Prompts were neutral and consistent across both conditions.

Scoring. The participant's responses were transcribed and scored by the investigator. A research assistant coded the cassette tapes so that the investigator was unaware of the condition being scored. The steps presented to the participants were divided into syntactical units, with each unit having a value of one point. A syntactical unit was defined as a verb, an object of a verb, or a prepositional phrase (e.g., “Make/hill/with sand” equaled three syntactical units and therefore three possible points). See Appendix for the 11 steps and the analysis of syntactical units. Substitution of functional synonyms was allowed. For the dependent variable free recall, the score was the number of syntactical units recalled correctly. The total possible score for free recall was 41. For order, a point was rewarded if a task step was recalled in its correct slot of order. For a step to be considered recalled, at least two of its syntactical units had to be recalled. The total possible score for order was 11.

Results

Data analysis was based on the results of 73 children with 36 children (17 boys and 19 girls) participating in the hands-on condition, and 37 children (14 boys and 23 girls) participating in the demonstration condition.

Interrater Reliability

To test for interrater reliability, a research assistant who was blind to the purpose, hypotheses, and conditions of the study was recruited to re-score 25 randomly selected tape recordings of the participants. The Shrout and Fleiss (1979) intraclass correlation coefficient for fixed effects was used. This procedure assesses interrater agreement between a specified set of raters (in this case, two raters). A .990 agreement was found for free recall scores, and a .994 agreement was found for order scores.

Hypotheses testing

An alpha level of .05 was used for all statistical tests. Participants in the hands-on condition had a mean recall score of 22.81 (SD = 6.87), while participants in the demonstration condition had a mean recall score of 17.97 (SD = 8.68). A one-tailed t-test confirmed that hands-on occupation led to significantly more recall than the demonstration condition, $t (71) = 2.63, p < .005$. The effect size $d$ equaled .62, a moderate effect according to Cohen (1988).

Participants in the hands-on condition had a mean order score of 4.17 (SD = 3.36), and participants in the demonstration condition had a mean order score of 3.32 (SD = 3.47). The task step order scores were not normally distributed and lacked variance; therefore, a Mann Whitney $U$ test was used. No statistically significant difference was found between the two conditions. Effect size was not calculated because of problems with this measurement.

Discussion

The results for the recall variable of the current study are consistent with the results of past studies involving the effects of hands-on learning on children's recall ability (Buddelmeyer, 1995; Vessey, 1988). Vessey (1988) found that an approach involving oral presentations and hands-on student participation led to greater recall and recognition scores than either a demonstration approach or a control group. Buddelmeyer (1995) found that children with learning disabilities who participated in hands-on learning remembered more than those who learned by demonstration. The results of the current study also are consistent with the results of prior studies involving healthy adults of various ages (Vákil et al., 1998) as well as adults with cognitive impairments (Eakman & Nelson, in press; Warner, 1989).

These results support traditional principles and practices within occupational therapy as well as the principles of pragmatism as espoused by Dewey (1916, 1966). Learning by doing is characteristic of occupational therapy. The question is, what are the components of hands-on learning that make it more effective than passive styles of learning? The occupational form of “volcano-making” provides an excellent example of the special potentials of hands-on learning. Occupational analysis (Nelson, 1994) suggests that the making of a volcano provided the child with special opportunities for two types of feedback: sensory/perceptual meanings as well as symbolic meanings. The sensory/perceptual meanings included the tactile, proprioceptive, and visual experiences enjoyed as the child made a mound out of the sand and dug a hole in the middle of the sand. Sand has a gritty texture, sticks to the hands, and provides some resistance to digging. The measuring of items such as baking soda, soap, vinegar, water, and food coloring provided proprioceptive and tactile sen-
expressions of weight that are integrated with visual information. In contrast, the demonstration condition provided no special tactile and proprioceptive perception, and the visual and auditory input of the demonstration and instructions were not integrated with somatosensory input. In like manner, the smell of the vinegar was present in both experimental conditions, but it could be integrated with tactile and proprioceptive input only in the hands-on condition.

The other type of meaning that was possible in the hands-on condition was symbolic in nature. In the hands-on condition the child had the opportunity to experience success at each stage of the occupation (each sub-occupation). The child was able to see that his or her own occupational performance resulted in a product (an impact) that matched the rules for this occupational form, as represented in the instructions. The final reward for hands-on doing was the visually striking image of an erupting volcano. This repeated subjective experience of personal success was not possible in the demonstration condition where the child could only observe the success of an adult.

Prior research in the area of subject-performed tasks has emphasized the sensory/perceptual meanings of hands-on occupation. For example, Vessey (1988) discussed the importance of the multisensory nature of active learning. However, the importance of symbolic meaning is also important. The sense of personal efficacy that one gets by doing something well (according to personal and sociocultural criteria) is an additional component to hands-on learning. The question arises, which type of meaning—sensory/perceptual or symbolic—is more responsible for memory and recall? Is there a difference depending on what is being learned? Is there a difference depending on the duration of the learning, or the capacity of the person to transfer the learning to increasingly complex situations? These are important areas for future research, but it will be difficult to separate the sensory/perceptual aspects of an occupation from the symbolic aspects, because the two aspects are typically found in hands-on learning. As with many occupational phenomena, hands-on learning is naturally multidimensional.

In the current study, the results for the order variable were ambiguous. This ambiguity may reflect a problem in how the order variable was scored. If a participant skipped a step, the remaining steps were automatically in the correct order slots. A review of raw data revealed that many of the participants in both conditions had difficulty remembering the fourth step; therefore, they received scores of three or less. This resulted in skewness and lack of variance for the order variable. Therefore, the statistical test of order may not reflect participants’ actual memory of order. The authors continue to believe that the separate study of order has potential value, because successful completion of many occupations depend on order. For example, careful attention to proper order is necessary for safety and independence in wheelchair mobility and transfers. Further study of hands-on occupation should operationalize order in a way that does not excessively penalize errors early in the sequence.

Limitations

The present study had several limitations. One limitation was that the principal investigator administered the experiment. To help control against bias, the investigator followed a strict protocol for administration and scoring of the results. When scoring the tape recordings, the investigator was blind to experimental condition. Additionally, a research assistant independently scored 25 of the tape recordings for interrater reliability.

Another limitation was the limited number of schools that participated. While five schools were invited to participate, only two schools took part. The two schools used in the study were diverse in nature, but a larger, more heterogeneous sample could have improved the representativeness of the sample. Another problem was that different testing settings were used at each school, and all of the participants were tested at different times and days of the week.

A final limitation was the use of a tape recorder to score the participant’s responses. The tape recorder was an unnatural aspect of the occupational form, and may have affected some of the participants responses. Some of the participants appeared hesitant and nervous to be tape recorded, which may have had a negative effect on their recall performance. However, this was balanced across the two experimental conditions.

In addition to correcting the above limitations and developing a better way to score the task step order variable, future studies could examine the effects of hands-on doing on long-term recall performance. Participants could be scored once at the completion of the task, and then again after a specified time period. Another idea would be to test procedural memory by measuring how well subjects complete the task after some specified time period (as opposed to asking them to state verbally the steps involved). Future studies may also include other age groups, especially older persons, and may incorporate different occupations from the one utilized in this study. Almost all the clinical populations seen by occupational therapists, whether with cognitive impairments or not, need to learn multi step procedures. Do they learn more effectively through hands-on occupation than by other methods?

Conclusion

The results demonstrated that participants were able to recall more information when engaged in a hands-on teaching method versus a demonstration method. The findings of this study have important implications for both education and occupational therapy. Active learning and
participation in meaningful occupation have been at the core of occupational therapy since its inception. This study contributes to the establishment of a valid base of research supporting the principle of hands-on learning. ▲

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Appendix

Instructions and Syntactical Units

Make/hill/with sand. (3)
Remove/sand/from top and center/of hill. (4)
Place/can/in center/of hill. (4)
Measure/baking soda. (2)
Put/baking soda/in can. (3)
Measure/soap/vinegar/and water. (4)
Add/soap/vinegar/and water/to plastic cup. (5)
Stir/soap/vinegar/and water/with spoon. (5)
Add/three drops/of red food coloring/to the plastic cup/with the eyedropper. (5)
Stir/with spoon. (2)
Pour/mixture/into can/in sand. (4)

References


