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Prone Extension in Four-and Five-Year Old Children

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Abstract

Objective. This study was designed to test the effects of added imagery on the performance of children assuming prone extension posture. Imagery was used to add purpose for maintaining prone extension, a posture considered important for sensory integration.

Method. Four- and five-year-old children ($N = 36$) were randomly assigned to the imagery condition or the rote condition, with 31 completing all procedures. Each participant was asked to hold the prone extension posture for as long as possible. In the imagery-based condition, the child was asked to fly like an airplane to Disneyland. This group had a picture of Disneyland and famous characters placed in the visual field. In the rote condition, the instructions given were to hold this type of body posture. Each child was videotaped.

Results. A 2-way analysis of variance (experimental condition X gender) revealed that there was not a statistically significant difference between the imagery-based condition and the rote condition, $F(1, 27) = .02$, $p = .88$. Girls performed better than boys, $F(1, 27) = 5.9$, $p = .02$. By chance assignment, there were more girls (10) than boys (5) in the rote condition and more boys (11) than girls (5) in the imagery condition.

Conclusion. This study does not support the hypothesis that imagery elicits better occupational performance, but the results might be due to an unexpected disproportioning by gender through random assignment.
The Effects of Imagery-Based Occupation on Duration of Prone Extension in Four- and Five-Year Old Children

Occupational therapy is unique among professions in regards to the use of purposeful doing or occupation since being founded in 1917. Bird T. Baldwin (1919), an advocate for the importance of purposeful occupation, suggested occupationally embedded exercise increased one’s endurance and willingness to participate in comparison to exercise alone. He viewed the person as complex with many intricate systems that are enhanced by voluntary involvement in therapeutic occupation.

Nelson (1988) asserted that an occupation must have meaning in order to be purposeful for the individual. Meaning is an interaction between a person and an occupational form. It is one’s interpretation of an occupational form that leads to purpose. Purpose is a felt emotion and causes the person to desire an outcome. Nelson and Peterson (1989) indicated the significance of meaning in their analysis of enhancing therapeutic exercise through occupation. A person finding meaning in an occupation will in turn have a sense of purposefulness. In one of many research studies, Yoder, Nelson, and Smith (1989) focused on embedding exercise within an occupation to encourage a rotating arm motion. The subjects who were told that they had been stirring cookie dough to make cookies performed more repetitions than those in the group told to stir for the purpose of exercise alone.

There are different ways to classify occupational forms that can be of an advantage to patients (Lang, Nelson, & Bush, 1992). One way is in terms of naturalistic, simulated, and imagery-based occupations (Nelson & Peterson, 1989). Naturalistic occupational forms involve exercise that occurs spontaneously as a result of one’s daily
occupations. An example of this would be the exercise a person experiences while painting the sides of a house. In simulated occupational forms, the environment has been altered by the therapist to mimic naturalistic forms in some way. Imagery-based occupation is another approach to enhancing therapeutic exercise. Nelson and Peterson defined imagery-based occupation as verbal or pictorial stimuli that elicit imagined or visualized movement or performance even though little physical support (material) is present in the immediate environment. An example of this might include reaching one’s arm up and back down while pretending to put dishes away in the cupboard. Although no dishes are present, the patient imagines the task, contributing to an increase in the range of motion in the shoulder.

There are several studies that have analyzed the individual effects of materials-, imagery-, and rote-exercise based occupational forms. Lang et al. (1992) compared these occupational forms among nursing home residents. This study focused on the number of repetitions completed during material-based occupation (kicking a balloon), imagery-based (imagining kicking a balloon), and rote exercise (kicking motion). The results of the study indicate more repetitions from the participants when taking part in the materials-based occupation than in the imagery-based and rote exercise conditions.

DeKuiper, Nelson, and White (1993) completed a follow up to this study and measured not only exercise repetitions but also the vertical distance and speed of movement. The results agreed with the findings of Lang et al. Thomas (1996) developed a similar study by including elderly females living independently and adding the components of heart rate and self-perceived rest period.
Riccio, Nelson, and Bush (1990) also studied the effects of imagery-based occupations compared to rote exercise in elderly female residents of a nursing home. Participants were told to raise their arms and reach as though they were picking apples and then placing them in a basket on their laps. Instructions were given to practice this motion until the participant was too tired. The subjects also were told to reach down with both arms pretending to be picking up coins that had been dropped and placing them on their laps. The results of the reaching up exercise were statistically significant in support of the study’s hypothesis, that imagery will elicit exercise. The differences in the reaching-down exercise were not statistically significant.

Wu, Trombly, and Lin (1994) compared the effects of materials-based, imagery-based, and rote exercise in a study that included female subjects of college age. The participant’s quality of movement was evaluated using the Waterloo Spatial Motion Analysis & Recording Technique (WATSMART). Each participant was asked to a) pick up a pencil from a pencil holder and prepare to write her name (materials-based), b) imagine picking up a pencil from location equal to where the pencil holder was placed and pretend to prepare sign her name (imagery-based), or c) produce the movement of reaching forward in front of the subject (rote exercise). A contrast analysis completed after the omnibus F indicated that the materials-based occupation produced a better quality of movement in terms of less reaction time needed to plan the movement when compared to the imagery-based and exercise conditions. Movement time in seconds and the number of movement units were also significantly lower in the materials-based condition in contrast to the other two conditions. Ross and Nelson (2000) provided further support to this idea. The results of this study indicate a quicker reaction time, a
smoother movement (requiring fewer movement units), more direct movement, and lower amplitude of peak velocity in those subjects participating in the material-based occupation. These findings validate the importance of purposefulness and the role it has on the quality of occupations performed.

Hsieh, Nelson, Smith and Peterson (1996) conducted a study of adding purpose to occupations and comparing it to the rote exercise in terms of the number of repetitions. This study of persons with hemiplegia involved the actions bending down, reaching, standing up, and extending the arm. The conditions included using small balls (materials-based) that were thrown at a target, imagining that there are balls on the ground, and the rote exercise condition. The results of the study supported previous studies involving added purpose to increase the number of exercise repetitions in participants.

A study completed by Sakemiller and Nelson (1998) focused on adding occupationally embedded exercise to increase functional prone extension in children. Single case experiments on two children with cerebral palsy inquired as to whether adding purpose would increase the range of neck and back extension. A game was introduced to the children, improving neck and back extension in contrast to the baseline established at the beginning of the study. The results further substantiate the use of purposeful occupation as a means to enhance meaning and performance.

In review, these studies have provided evidence that materials-based occupational forms add purpose to traditional rote exercise and enhance performance. However, there is not substantial evidence from previous studies that imagery-based occupational forms also add meaning and purpose to occupations. The subjects participating in these studies
mainly consisted of elderly nursing home residents, stroke patients, and healthy college aged students. Sakemiller and Nelson (1998) is the only study to assess functional prone extension in children after adding occupationally embedded exercise.

Further research is needed to study the effect of imagery-based exercise on children. One of the methods occupational therapists use to assess children is the prone extension postural test. The prone extension posture first begins to develop when a child is five or six months old (Ayres, 1979). Ayres defines the prone extension posture as the position when a child supports his body weight on his lower abdomen while his head, chest, arms, and legs are raised against gravity. The prone extension posture is essential for inhibiting or integrating the tonic labyrinthine reflex, and is viewed as a significant step in motor development (Ayres, 1972, p. 81). This position is also significant to a child being able to maintain proximal stability (Connor, Williamson, & Siepp, 1978). This type of fundamental postural movement is the basis for motor control (Bobath & Bobath, 1964). The presence of this posture is imperative to developing the muscles and motor skills needed for standing and walking. The inability to maintain the prone extension posture has been found to be a sign of poor sensory integration, which is commonly associated with learning disorders (Ayres, 1972, p. 98). A lack of this ability often results in a diminished amount of vestibular-proprioceptive inputs to extensor muscles, specifically those in the neck and trunk. Children with this deficit frequently have problems with integrating gravity and movement sensations.

Two studies have evaluated the performance of healthy children aged four to nine in the prone extension postural position (Gregory-Flock & Yerxa, 1984; Harris, 1981). These studies’ primary focus has been the quality and duration of this position. The data
from these sources reveal similar findings, supporting Ayres’ initial assertion that most children age six and older can sustain the prone extension position with moderate exertion.

In this study an imagery-based occupational form will be designed to elicit prone extension posture in 4-year-old and 5-year-old children. It is at this age when the prone extension posture has not fully developed, and there is more variability in performance compared to older children. Harris (1981) evaluated the quality and duration of the prone extension position in 4-, 6-, and 8-year-olds. This was the first study to include 4-year-olds. A six point scale, with a range in scores of 0 - 12, was created and tested by 10 occupational and physical therapists. The inter-rater reliability for this rating scale was \( r = .89 \). Measurement criteria included beginning timing when the child lifted his or her head off of the mat and continued until arms, head, or legs touched the mat, or until 30 seconds had passed. A significant difference was found among the three age groups. The 4-year-olds \((n= 26)\) had a mean duration of 18.15 seconds and \(SD = 13.45\). The 6-year-olds received a mean average of 28.93 seconds of duration, \(SD = 5.67\). Lastly, the 8-year-olds scored a mean of 30 seconds, \(SD = 0\). The findings of this study support Ayres’ belief that most children six years and older are able to hold the prone extension position for 30 seconds with moderate exertion.

Gregory-Flock and Yerxa (1984) also presented a standardized method for directing and scoring the prone extension postural test. The participants of this study ranged in age from 4-years-old to 8-years-old. The same six point rating scale was used as Harris administered in the prone position test. The quality of performance was analyzed during the first 15 seconds of maintaining the posture. The median duration for
4-year-olds, \( n = 43 \), was 17.2 seconds and the average score of quality being 8.6. Once again, the amounts of time 4-year-olds were able to maintain the prone position was found to be significantly less than older children.

The present study is an extension of Shafer (1997), who assessed sixty-nine 4-and 5-year-old children assigned to one of two groups. All subjects were asked to maintain the prone extension posture for as long as they could. One group was given an imagery-based condition in which each child was instructed to fly like an airplane. The rote condition involved giving verbal instructions to maintain the posture as in standard testing. The dependent variable measured was the duration of time in seconds the prone position was sustained. A preliminary data analysis showed the duration variable was positively skewed and required transformation. An analysis of covariance (ANCOVA) revealed a significant difference between the imagery-based condition and the rote condition, \( F(1, 55) = 5.38, p = .02 \). This study supports the theory that imagery can enhance motor performance in children. However, the Shafer study is marred by a lack of documented random assignment to groups.

This study reflects the original research, focusing on healthy four- and five-year-old children. This age group is appropriate since the prone extension posture is still maturing. These children will be assessed in the duration of prone extension in one of two conditions: a rote exercise condition and an imagery-based condition. Given the results of Shafer (1997), it is predicted that there will be a statistically significant difference between the duration of performance in the prone extension between the two conditions.
Method

Subjects

Preschool and kindergarten children were recruited for the study from four different schools in Wooster and Shreve, Ohio. A power analysis for a two-sample $t$-test based on Shafer’s data was used to determine the number of subjects needed. The original plan was designed to include 82 subjects to participate in the study; however, only 36 consent forms were obtained from families of potential participants. The subjects were grouped according to sex and age: 13 4-year-olds (6 females, 7 males) and 23 5-year-olds (12 females, 11 males). All subjects that participated in the study were considered healthy and would have been excluded if any signs of developmental, emotional, or physical delays were present. The teachers were asked two questions regarding each child: a) To the best of your knowledge, is the child considered healthy with no known or documented orthopedic or behavioral problems? b) Is the child considered developmentally appropriate for age in perceptual, fine motor, and language skills? If the teacher responded “no” to either question, the child would not be included in the study. A letter of informed consent was sent home with each child two weeks prior to testing. Of the eligible 36 participants, 31 were considered in the final results of the study. Two children were excluded from the study for not assuming the extension posture correctly, and three children were unwilling to participate.

Procedure

The subjects were randomly assigned to one of two groups. Randomization was completed using permutated blocks of 2, 4, 6, and 8. Codes were created by research
Each subject was evaluated by the student investigator individually in a room outside the classroom, with the exception of the Triway preschool. The school’s policy did not allow a child to leave the room with an individual who was not a staff member. An area of the room was secluded from the other children and used for the duration of this study. Each child was asked to remove his or her shoes and to be seated on a mat. All of the participants were seated in the same direction, facing a television. The child was given the instruction to watch a video, which provided the instructions and a demonstration of the prone extension posture that was appropriate to the experimental condition. The procedure in Shafer’s study was different in regards to the instructions administered; the researcher demonstrated the prone extension position and gave verbal instructions at the time of the assessment.

For the rote exercise condition, the seated subjects watched a video recording of a child demonstrating the prone extension postural test. In the video, the student investigator’s recorded voice provided commentary throughout the video giving the following instructions: “I would like you to lift your head, arms, and legs off the mat as Tyler is demonstrating for you. Now take this time to practice before we begin.” The video included a boy of the same age demonstrating the prone extension posture. Ten seconds were allowed for the participant to practice. During this time further instruction from the video was given: “Make sure your arms, head, and legs are off the floor and remember to keep breathing.” The recorded voice continued as follows: “All right, now when I say ‘go’ I want you to lift your head, arms, and legs off the mat just as you
practiced and stay in that position for as long as you can. Ready, go.” It was intended that there would be no verbal corrections made as each student practiced the position as was done in Shafer’s study, however, many participants found it difficult to follow instructions and to imitate the correct position from watching the video. In these cases, the research investigator provided repeated instruction and included live demonstration in addition to the video.

For the imagery-based condition, the children were instructed by the video as follows: “Now we are going to play a game of pretend. Do you see the poster in front of you with Mickey Mouse on it? I want you to pretend like you are an airplane and you are going to fly for as long as you can all the way to Disneyland. Now take this time to practice before we begin.” Once again during this time the participant was given 10 seconds to practice the prone extension posture. The commentary continued: “Make sure your arms, head, and legs are off the floor and remember to keep breathing.” The participant was then told to relax and the video continued with the final instruction: “Now, I want you to raise your arms, head, and legs just like you practiced and pretend you are an airplane. Don’t forget to fly for as long as you can. Ready, go.” As in the rote condition there is also a video clip of the same boy demonstrating prone extension posture. The poster of Disneyland and Disney characters was placed at eye level when the child’s head was off the mat. As with the rote condition, selected participants were retested using live demonstration in addition to watching the same video with instructions.

Each student’s performance was videotaped and later analyzed by the student investigator and a research assistant blinded to the study. The second rater was masked
to each condition and was not exposed to any indicators of the experimental condition.

Scoring of duration was completed by using a stopwatch for each child’s performance. Timing initiated when the child’s head, upper trunk, arms, thighs, and knees were raised from the mat. The knees could be flexed or extended. Timing stopped when the child was no longer able to sustain the prone position, which occurred when the child’s head, arms, fingers, knees, or feet touched the mat. The research assistant practiced scoring on adults first with the student investigator providing specific guidelines on what to observe. The training also included timing five children under the age of eight who were not a part of the study. The research assistant viewed the tape of the participants and timed each participant independently for interrater reliability, which is reported as the intraclass correlation coefficient.

The plan for data analysis included a check for skewness. If the data were skewed, as occurred in the Shafer study, transformations would be completed. The plan was for an analysis of covariance to test the hypothesis, with age as the covariate, as was done in the Shafer study.

Results

Interrater reliability was very strong, with ICC > .99 in a randomized test suitable for generalization to future situations.

Duration of Prone Extension

An initial data analysis confirmed that there was no skewness or distributional problems, so a transformation was not necessary for this study. It was planned that age was to be used as a covariate; however, this was not done because of the small correlation between age and the dependent variable, with $r = .24$. 
Preliminary analysis suggested a possible gender difference (see Table 1), so the final analysis involved a 2-way analysis of variance (experimental condition X gender). The findings of the 2-way ANOVA indicated there was not a main effect for imagery versus rote, $F(1, 27) = .02, p = .88$. However, there was a significant difference between girls and boys in both conditions, $F(1, 27) = 5.9, p = .02$. The girls in the imagery condition ($n = 5$) scored an average of 45.4 seconds, $SD = 21.5$ versus the boys in the imagery condition ($n = 11$) who had an average of 27.1 seconds, $SD = 17.5$. In the rote condition, girls ($n = 10$) had a score of 36.7 seconds, $SD = 19.5$, compared to the boys ($n = 5$) who scored an average of 22.1 seconds, $SD = 3.3$.

Discussion

The purpose of this study was to determine whether the addition of an imagery-based component of pretending to fly like an airplane to Disneyland would improve the performance of typical 4- and 5-year-old children assuming and maintaining prone extension posture. The imagery component, which was created to provide meaning to children, was predicted to elicit better performance in comparison to the rote condition without the use of imagery. The results of this research study, however, did not support this hypothesis.

This study does not support the evidence of previous studies that investigated the effects of adding meaning and purpose to a rote task on occupational performance (DeKuiper, Nelson, & White, 1993; Hsieh, Nelson, Smith, & Peterson, 1996; Lang, Nelson, & Bush, 1992; Nelson & Peterson, 1989; Riccio, Nelson, & Bush, 1990; Ross & Nelson, 2000; Sakemiller & Nelson, 1998; Wu, Trombly, & Lin 1994). Collectively, these studies support adding purpose to occupations by means of imagery-based and
materials-based occupational forms. Participants’ performance revealed a marked enhancement in comparison to participants in the rote condition. In Shafer’s study it was found that adding an imagery component to a rote exercise increased the duration of performance in comparison to the group without imagery. The present study is similar to these studies in regards to using an occupational form to add meaning and purpose to a rote postural test; however, the addition of an imagery component did not elicit significantly better performance than the rote exercise condition.

It is uncertain why the imagery-based group did not elicit better performance than the participants in the rote group. There were a marked number of girls randomly selected for the rote group. In this study girls maintained the prone extension posture longer than the boys. The girls were over-represented in the rote condition and had a higher average score than the boys. The efficacy of imagery might well have been supported if there had been an equal number of boys and girls in both groups.

Another problem was sample size. It was not possible to recruit subjects as required by the power analysis, and there were five participants not included in the results of this study. A third problem was that the instructions provided could have been more concise. Each participant was asked to watch the video, which required both visual and auditory instruction. The participants in the imagery group were asked to focus on the poster of Disneyland placed in front of them while still listening to the video. It might have been difficult for children in this age group to focus their attention on the video component and transition to using their imagination to pretend they were flying like an airplane to Disneyland.
Previous studies have added imagery as a means of enhancing performance of rote exercise. There are factors to take into consideration when using this method. Riccio et al. (1990) reported some disadvantages of using imagery without incorporating physical materials. These findings include: a) a patient’s perceived image or memory may be inaccurate; b) a flawed performance due to the individual being incapable of reproducing the intended movement; and c) individuals might struggle to develop mental images which rely on imagination. Ultimately, the intended meaning and purpose of an occupation may hold varying degrees of significance among individuals based upon their memories and life events. In the present study the participants were instructed to watch a video and listen to instructions in addition to using their imagination. The technical instructions may have been too difficult to comprehend and may not have provided the ideal context to promote the use of the participant’s imagination. The average scores of both the imagery-based group and the rote exercise group in this study, however, were higher overall in comparison to the scores in Shafer’s study. In the previous study the average length of time the prone extension posture was maintained in the imagery group was 20.2 seconds, $SD = 11.2$, and the rote condition maintained an average of 17.2 seconds, $SD = 21.5$.

In this study the results do not support the theory that suggests prone extension posture is a skill that is maturing in 4- and 5-year-old children. Both age groups were able to assume the prone extension posture, and age did not strongly predict fluctuations in quality and duration. Thus age was not used as a covariate. Although prone extension posture can be assumed and maintained by young children, Harris (1981) reports that the performance of 4-year-olds assuming and maintaining the prone extension posture is not
an accurate measurement tool that should be used to classify whether a child is typical or inclined to have sensory processing issues or a learning disability.

This study has limitations that may have affected the results of the study. This study was designed to be a continuation of a study completed ten years ago. Disneyland and Disney characters may have been more popular and had more meaning to young children during the time when Shafer’s study was completed nearly ten years ago. The overall level of meaning presented by the imagery condition may have been enhanced by knowing and implementing a current cartoon character preference of four- and five-year-old children. This may have produced different results. The incorporation of the videotaped instruction may not have been clear and easy to comprehend as direct verbal instruction. Also, the children appeared to be self-conscious that their performance was being videotaped, and this was a distraction to many of the participants. Lastly, in three of the four schools, there was not a quiet, secluded environment to conduct the study due to limited space and school policies.
References


# Table 1.

Mean Scores and Standard Deviations for Maintenance of Prone Extension Posture

<table>
<thead>
<tr>
<th>Group</th>
<th>Imagery</th>
<th>Rote</th>
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<tbody>
<tr>
<td></td>
<td>Mean (M)</td>
<td>Mean (M)</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation (SD)</td>
<td>Standard Deviation (SD)</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Girls</td>
<td>M = 45.4</td>
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<tr>
<td></td>
<td>SD = 21.5</td>
<td>SD = 19.5</td>
</tr>
<tr>
<td></td>
<td>N = 5</td>
<td>N = 10</td>
</tr>
<tr>
<td>Boys</td>
<td>M = 27.1</td>
<td>M = 22.1</td>
</tr>
<tr>
<td></td>
<td>SD = 17.5</td>
<td>SD = 3.3</td>
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<tr>
<td></td>
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<td>N = 5</td>
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