Materials-Based, Imagery-Based, and Rote Exercise Occupational Forms: Effect on Repetitions, Heart Rate, Duration of Performance, and Self-Perceived Rest Period in Well Elderly Women

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Key Words: aging • human activities and occupations • purposeful activities • therapeutic exercise

Objectives. This study extends previous research that contrasted occupational forms with elderly persons living in institutions to include elderly women living independently. In addition to differences in number of repetitions elicited, the current study measured heart rate response and perceived rest period duration.

Method. Forty-five women over the age of 65 years were randomly assigned to one of three occupational forms: materials based (kicking a balloon), imagery based (kicking an imaginary balloon), and rote exercise (performing a kicking movement without a balloon or imagery prompt). Subjects were instructed to perform the assigned lower-extremity movement until they fatigued and after a self-determined period of rest indicated when they felt able to do another set of movements. Dependent variables included number of repetitions of movement, heart rate (at baseline, at completion of movements, at end of rest period), duration of movement, and self-perceived rest period. Group means for each variable were compared using analyses of variance.

Results. Groups showed no significant difference in baseline and demographic data. Subjects in the materials-based occupational form performed significantly more repetitions and required a significantly longer self-perceived rest period than subjects in the imagery-based and rote exercise forms. There were no significant differences among the groups for heart rate response. Duration of movement and number of repetitions variables were strongly correlated ($r = .95$), indicating lack of independence.

Conclusions. The materials-based occupational form elicited a quantitatively different performance than the other forms. Given the relatively fuller experience (i.e., interaction with an object, clear objective) of the materials-based form, an occupational form that has added meaning for the person appears to result in enhanced performance when compared with forms that lack strong meaning and suggest more limited purposes.

Occupational therapy's unique contribution to patient treatment is its use of therapeutic occupations (purposeful activities) to remediate and promote function (performance of occupations to the satisfaction of self and others). The occupational therapist plans or synthesizes the occupational form (objective set of circumstances external to the person) that elicits, guides, or structures the person's occupational performance. Such efforts are designed to elicit immediate occupational performances that will most positively change the patient's developmental structure (e.g., sensorimotor, cognitive, and psychosocial abilities) and future, overall occupational performance (Nelson, 1988, 1994). Intervention by
the occupational therapist is commonly directed at performance components, such as range of motion, strength, and endurance (Zemke, 1995). These and other components provide the foundation to daily living, work, and play and leisure occupations (American Occupational Therapy Association [AOTA], 1994). Remediating dysfunction at the component level (i.e., strength, endurance) often requires repetition of movements to build skills needed for these occupations (Trombly, 1995). Occupational therapists are challenged to create therapeutic occupational forms that encourage repetition of specific movements and work by desired muscle groups. By varying elements of the occupational form (e.g., use of rote exercise vs. a game), therapists set the stage for the patient to find more or less meaning in that form. When patients find different meanings in occupational forms, a variety of purposes may be generated that will result in diverse occupational performances (Christiansen, 1991; Fidler, 1981; Nelson, 1988, 1994). Thus, meaning and purpose act as mediating variables that, in part, explain performance differences elicited by contrasting occupational forms (King, 1993; Licht & Nelson, 1990; Yuen, Nelson, Peterson, & Dickinson, 1994).

**Literature Review**

Previous studies on the effects of occupational forms on performance have shown that subjects perform considerably more repetitions of movement before perceived fatigue in forms where object-driven tasks are compared with rote exercise (DeKuiper, Nelson, & White, 1993; Hsieh, Nelson, Smith, & Peterson, 1996; King, 1993; Lang, Nelson, & Bush, 1992; Miller & Nelson, 1987; Steinbeck, 1986; Yoder, Nelson, & Smith, 1989). Studies have also shown that occupational forms that incorporate meaningful objects and tasks result in increased range of motion (Sietsema, Nelson, Mulder, Mervau-Scheidel, & White, 1993); better-organized movement (Wu, Trombly, & Lin, 1994); greater accuracy of movement (Licht & Nelson, 1990; Yuen et al., 1994); and longer involvement in tasks, even when pain is present (Heck, 1988). The majority of subjects in these studies were of college age. Of the studies on occupational forms that involve elderly persons, two contrasted materials-based, imagery-based, and rote exercise occupational forms, using nursing home residents as subjects (DeKuiper et al., 1993; Lang et al., 1992).

Researchers contrasting different occupational forms have also investigated their influence on subjects' heart rates. These studies produced conflicting results. Kircher (1984) and Bloch, Smith, and Nelson (1989) found significantly greater heart rate increases during a jumping-rope task than those seen during a jumping exercise without a rope. Steinbeck (1986) found that when perceived exertion was held constant, subjects worked harder during an upper-extremity game than they did during a matched, upper-extremity exercise requiring similar movements and physiological demands. He found that the reverse occurred for the matched lower-extremity conditions where subjects achieved significantly higher heart rates during the exercise than during the game condition. Three additional studies found no significant differences in subjects' heart rates in response to varying occupational forms (Heck, 1988; Morton, Barnett, & Hale, 1992; Thibodeaux & Ludwig, 1988). The effect of varying occupational forms on heart rates is therefore not presently clear. In addition, studies examining heart rate used either college-aged or young adult subjects, which limits generalizability to elderly persons.

Research on occupational forms has not addressed their effect on the need for rest periods during or after rote exercise or occupationally embedded exercise. Such studies are found in both the cardiovascular literature (McArdle, Katch, & Katch, 1986; Wenger & Hellestein, 1984) and the motor control and motor learning literature (Schmidt, 1988). Researchers of cardiovascular response to exercise tend to define rest as the amount of postexercise time needed to reapproximate baseline heart rate (American College of Sports Medicine, 1991). Because cardiovascular rehabilitation requires maintaining target heart rates for a predetermined period, rest periods are avoided or kept to a minimum, with rest generally following an extended period of exercise.

Motor control and motor learning research addresses rest within the framework of structuring practice (Schmidt, 1988). In motor learning research, rest periods are usually of a set duration determined by the investigator without input from the subject. Research has compared the amount of work specific muscles can perform after different types of rest periods (Crutchfield & Barnes, 1993). For example, considerably more work can be performed by specific muscles when rest periods are passive and consist of a diverting task (i.e., mental or physical task that does not involve the tested muscles) (Asmussen & Mazin, 1978).

During therapy, occupational therapists often use rest periods between bouts of effort designed to strengthen peripheral muscles, increase range of motion, or restore a skill (Trombly, 1995). In those instances, rest periods are intended to permit at least partial recovery of the muscles and, therefore, are commonly interspersed among periods of effort. The appropriate length or sufficiency of rest periods is a clinical judgment. Therapists may use cardio-
vascular response markers (e.g., blood pressure, heart rate) to assist in this determination; however, it is the patients' indication of their own state of readiness that typically initiates another period of movement. Because patients are commonly asked to judge their readiness to return to task, information on factors that affect perceptions of readiness could be helpful to clinical practice. No literature was found that addressed the effect of varying occupational forms on duration of self-perceived rest periods.

As in the Lang et al. (1992) and DeKuiper et al. (1993) studies, the present study examined whether there is a difference among materials-based, imagery-based, and rote exercise occupational forms in terms of the number of repetitions elicited and duration of movement before subjects indicate fatigue. The current study expanded on the generalizability of these studies by investigating the same three occupational forms with elderly women who live independently. In addition, the present study measured heart rate as a means of evaluating cardiovascular response differences among occupational forms as suggested by DeKuiper et al. Finally, to investigate whether there was a difference in when subjects perceive they were ready for an additional set of movements, the duration of self-perceived rest period was measured.

Method

Subjects

Women were recruited for the study via notices sent to two church-related groups for retired persons and three public housing complexes designed for independent persons over the age of 65 years. Criteria for participation included age of 65 years or more and freedom from visual, orthopedic, or cardiac conditions that would interfere with full participation in repetitious, lower-extremity movement.

Procedure

The subjects were randomly assigned to one of the three research conditions: materials based (kicking a balloon), imagery based (imagine kicking a balloon) and rote exercise (kicking) and were placed individually in a quiet room. A video camera was placed perpendicular to the plane of movement, permitting filming of the subject's leg movements. After completing preliminary exercises (i.e., breathing, rolling shoulders, raising arms), as described by Lang et al. (1992), a pulse meter was attached to the subject's index finger and positioned so that only the research assistant could read heart rates. Baseline heart rates were recorded at the start of movement. Subjects chose the leg they wished to use in the experiment, and the same instructions as those described in the Lang et al. study were presented verbally.

For the materials-based condition, seated subjects were told to kick a balloon (approximately 18 in. in diameter) with their chosen foot until they reported feeling too tired to continue. To facilitate rapid, repeated tosses of the balloon, a string was attached to the balloon, permitting the researcher to stand in one spot (approximately 5 ft directly in front of the subject) and quickly reel in the balloon after each kick. A rate of approximately one throw per 3.3 sec was achieved.

For the imagery-based condition, subjects were instructed to imagine a big red balloon coming toward their foot and to kick the imagined balloon with one foot until they were too tired to continue. For the rote exercise condition, subjects were told to kick their chosen foot in the manner demonstrated by the research assistant. Subjects were directed to perform the kicking exercise until too tired to continue.

Subjects who asked when to stop or how many exercises to do were told to do as many as they could and stop when they felt too tired to continue. When subjects indicated that they were too tired to continue, they were told to rest and inform the research assistant when they were ready to perform another set of movements. This self-perceived rest period was measured as the time between cessation of kicking and when subjects indicated that they were ready to begin a new set. Heart rates were recorded when fatigue was indicated and at the end of the self-perceived rest period.

Measurement

Cardiovascular response to research conditions was measured via heart rate by a digital pulse meter. The instrument had an error rate of ± 5% for readings from 30 bpm to 200 bpm as described in the instructions for use.

Number of repetitions of subject effort were counted by a research assistant during data collection. A second assistant independently verified repetitions by reviewing the session videotapes, establishing an intraclass correlation coefficient of .99. Duration of exercise and rest periods were measured via stopwatch during data collection. Session videotapes were reviewed to independently verify these data. Intraclass correlation coefficients were .97 for duration of exercise and .94 for rest periods.

Data Analysis

For a three-group comparison of each demographic and
dependent variable (age, heart rate, repetitions, duration of movement, rest period), an analysis of variance (ANOVA) was used, with alpha assigned a priori at .05. Previous studies have found that variables such as number of repetitions and duration of movement are highly correlated, indicating a lack of independence (Miller & Nelson, 1987; Riccio, Nelson, & Bush, 1990; Yoder et al., 1989). Data for repetitions and duration of movement as well as for repetitions and duration of perceived rest were compared with Pearson correlation coefficients. When high correlations were found, only the repetitions variable was analyzed further.

Results

Forty-five women met the study criteria. Their ages ranged from 65 to 93 years ($M = 76.67$ years, $SD = 7.99$). A one-way ANOVA showed that the three groups did not differ significantly in age, $F(2, 42) = 1.32, p = .28$. Subjects were very similar in age to subjects in the Lang et al. (1992) study ($M = 76.3$ years, $SD = 9.95$, range = 56–93 years) and somewhat younger than the subjects in the DeKuiper et al. (1993) study ($M = 84.86$ years, $SD = 6.08$, range = 76–98 years). Baseline heart rates ranged from 52 bpm to 103 bpm, with means of 73.3 bpm ($SD = 10.1$) in the materials-based, 75.5 bpm ($SD = 7.8$) in the imagery-based, and 76.6 bpm ($SD = 14.3$) in the rote exercise conditions. A one-way ANOVA showed that the three groups did not differ significantly on baseline heart rate, $F(2, 42) = .34, p = .72$.

Pearson correlation coefficients revealed that number of repetitions was highly correlated with exercise duration ($r = .95$) but less strongly correlated with duration of perceived rest ($r = .31$). Therefore, only the repetitions and perceived rest variables were analyzed further. Natural logarithm transformations were performed on the repetition and duration of perceived rest variables to reduce positive skewness and heterogeneity of variance, after which all skewness levels were less than 1 (Buchner & Findley, 1990; Howell, 1987). Transformed data are presented in Tables 1 and 2.

There were significant differences in the number of repetitions among the three conditions, $F(2, 42) = 11.45, p = .0001$. The Scheffé multiple comparison for differential main effects was used for post hoc analysis. The mean number of repetitions was significantly greater during the materials-based occupational form than during both the imagery-based and rote exercise forms. The mean difference in repetitions between the imagery-based form and the rote exercise form was not significant (see Table 1). The distribution of the repetition data revealed that none of the 15 subjects in the imagery-based condition and 2 of the 15 subjects in the rote exercise condition completed 60 or more repetitions, whereas 13 of the 15 subjects in the materials-based condition completed 60 or more repetitions. When comparing subjects who did the fewest number of repetitions, none in the materials-based condition completed 20 or fewer repetitions, whereas 5 in the imagery-based condition and 6 in the rote exercise condition completed 20 or fewer repetitions.

A one-way ANOVA of duration of self-perceived rest showed significant differences across occupational forms, $F(2, 42) = 14.1, p < .0001$ (see Table 2). The Scheffé multiple comparison revealed that the perceived rest period was significantly longer after the materials-based condition than after both the imagery-based and rote exercise conditions.

The rise in heart rates at the completion of each occupational form was similar. At the completion of each condition, the mean heart rates were 84.5 bpm ($SD = 10.6$) for the materials based, 86.2 bpm ($SD = 11.3$) for the imagery based, and 87.7 bpm ($SD = 11.4$) for the rote exercise. Mean heart rate change from baseline to completion of each condition was close to 11 bpm, with similar heart rate variability across groups.

### Table 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Materials Based</th>
<th>Imagery Based</th>
<th>Rote Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (raw score)</td>
<td>149.4</td>
<td>29.8</td>
<td>49.3</td>
</tr>
<tr>
<td>SD</td>
<td>126.8</td>
<td>15.9</td>
<td>60.1</td>
</tr>
<tr>
<td>Range</td>
<td>21–368</td>
<td>5–59</td>
<td>8–205</td>
</tr>
<tr>
<td>Median</td>
<td>80</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Transformed data</td>
<td>2.0</td>
<td>1.41</td>
<td>1.50</td>
</tr>
<tr>
<td>SD</td>
<td>0.42</td>
<td>0.27</td>
<td>0.39</td>
</tr>
</tbody>
</table>

*n = 15 for each condition.

### Table 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>Materials Based</th>
<th>Imagery Based</th>
<th>Rote Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived (raw score in seconds)</td>
<td>59.6</td>
<td>17.9</td>
<td>18.3</td>
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<tr>
<td>SD</td>
<td>45.7</td>
<td>14.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Median</td>
<td>43</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Range</td>
<td>10–158</td>
<td>5–68</td>
<td>6–33</td>
</tr>
<tr>
<td>Transformed data</td>
<td>1.66</td>
<td>1.15</td>
<td>1.23</td>
</tr>
<tr>
<td>SD</td>
<td>0.34</td>
<td>0.29</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*n = 15 for each condition.*
among the three groups for mean heart rate change were not significantly different, $F(2, 42) = .02, p = .98$. Heart rates after perceived rest periods were 77.5 bpm ($SD = 14.3$) in the materials-based, 79.9 bpm ($SD = 9.9$) in the imagery-based, and 84.8 bpm ($SD = 11.4$) in the rote exercise conditions. Mean postrest period heart rates among the three groups were not significantly different, $F(2, 42) = 1.43, p = .25$.

**Discussion**

The results of this study support the growing body of research that asserts that occupational forms differ in the performance that they elicit. The finding that subjects in the materials-based condition completed significantly more repetitions before reporting fatigue than those in the imagery-based and rote exercise conditions replicates the patterns found by Dekuiper et al. (1993) and Lang et al. (1992). It may be that the materials-based occupational form (kicking a balloon) is meaningful (i.e., involves a familiar object) and creates purposes (i.e., a clear goal of kicking the balloon), resulting in more movements than those evoked by the other forms. Comments from subjects during the materials-based form indicated playfulness or enjoyment (e.g., “I could do this with my grandchildren,” “It’s been a long time since I kicked a few field goals,” “I’d like to do this again another time”). Subject comments during the rote exercise condition focused on the amount of time to continue movements (e.g., “I’d like to stop, but my leg isn’t tired yet,” “How long do you want me to do this?”).

Several previous studies of younger subjects documented significantly different heart rate responses to varying occupational forms (Bakshi, Bhambhani, & Madill, 1991; Bloch et al., 1989; Kircher, 1984; Steinbeck, 1986). The lack of difference among subjects’ heart rates in the current study may be related to the subjects’ age. Although screening did not document subjects’ medication use, many elderly women take prescribed medications that can affect heart rate response to exercise (American College of Sports Medicine, 1991). Diuretics have the effect of increasing heart rate in response to effort, whereas beta blockers act to decrease heart rate response (American College of Sports Medicine, 1991). Such medications may have masked heart rate differences that were evidenced in younger subjects who are less likely to be taking such medications. Given the difference in age among the studies’ subjects, it is difficult to directly compare heart rate responses. It is also possible that the research tasks in the current study may not have placed sufficient stress on the cardiovascular system before the subjects responded to peripheral muscle fatigue. Thus, quadriiceps muscle (peripheral) fatigue may have been experienced before cardiopulmonary (central) fatigue (Borg, 1990) was sensed and responded to. In addition, it is unclear whether boredom with the tasks influenced the perception of fatigue and, if so, whether the three conditions were affected similarly.

The perceived rest period after the materials-based condition was significantly longer and more variable than the rest period after the other conditions, which was 36 sec or less for all but one subject. Only five subjects in the materials-based condition perceived themselves as ready to continue in 36 sec or less. In fact, three subjects in the materials-condition required 120 sec or more before indicating that they were ready to continue. Perhaps the subjects in the imagery-based and rote exercise conditions anticipated a shorter second round of movement and therefore felt ready to begin sooner (in absolute terms) than subjects in the materials-based condition. However, because most subjects in the materials-based condition completed twice to ten times the number of repetitions of subjects in the other conditions, they may not have required a concomitant rest period.

Another potential influence on performance was the pace of movement elicited by the different forms. The pace for the subjects in the materials-based condition was controlled by the researcher tossing the balloon at a consistent rate throughout each session, whereas the pace for the other two conditions was controlled by the subject. On average, subjects in the imagery-based condition completed one repetition every 1.4 sec, and subjects in the rote exercise condition completed one repetition every 1.7 sec. Subjects in the materials-based condition completed one repetition every 3.3 sec. When videotapes were reviewed, subjects in the imagery-based and rote exercise conditions tended to slow their pace as their sessions progressed. It is possible that the materials-based condition provided micropauses (Rodgers, 1986) that allowed a more sustainable pace, which may be especially important for elderly persons. Even though the pace was not controlled across the conditions, it is apparent that the subjects in the materials-based condition were motivated to continue moving for significantly more repetitions. Seeing the balloon approach and tailoring movements (e.g., “I could do this with my grandchildren,” “It’s been a long time since I kicked a few field goals,” “I’d like to do this again another time”). Subject comments during the rote exercise condition focused on the amount of time to continue movements (e.g., “I’d like to stop, but my leg isn’t tired yet,” “How long do you want me to do this?”).

This study’s findings indicate that materials-based occupations are more advantageous than imagery-based
or rote exercise occupations when numerous repetitions of movement are needed. Occupational therapists who create meaningful occupational forms that require attention and encourage interaction with the environment for the accomplishment of a goal may expect more repetitions and a longer period of involvement before the perceived need for rest. The self-determined rest period may be of longer duration than rest periods that follow forms lacking objects or generating narrow purposes or goals. However, duration of self-determined rest after materials-based occupational forms probably does not require a length of time proportional to the increased number of repetitions expected.

Limitations

Limitations inherent to this study need to be considered before application of the results. The researcher and assistants were aware of the study design and not blinded to subject group assignment, which could have produced experimenter bias. To reduce the risks of potential bias, protocols were strictly adhered to during data collection and videotape verification. Additionally, dependent variables were measured and checked by objective means (i.e., digital pulse meter, review of videotapes). Limitations of generalizability are determined by the study sample itself. This study did not examine performance of patients, but that of elderly women living in the community. Therefore, generalization of the results to elderly patients, men, or tasks involving the upper extremity must be done with caution.

Directions for Future Research

Although recognizing the limits of generalizability of this research, one can hypothesize that more creative, complex, or involved occupational forms may encourage even greater participation. Future research from many perspectives is needed to document the effects of occupational forms on overall performance (e.g., number of repetitions) and on supporting performance components (e.g., strength, range of motion).

Future studies could contrast the meaning and purposes generated by occupational forms in addition to evaluating differences in performance. The current study did not clarify the relationship between occupational forms and heart rate response. Future research could address heart rate response in a more homogeneous subject sample with a task with greater cardiovascular demand. Additional research on self-perceived rest would help therapists judge the optimal duration for rest, thus maximizing use of limited therapy time. A similar study could have subjects complete a second set of movements and compare performance among groups. Or researchers may want to manipulate rest patterns (i.e., self-determined vs. therapist-determined length of rest) and compare the effects on subsequent performance. The observation of these and other variables will add to the understanding of occupational performance and the means by which therapists may most effectively synthesize therapeutic occupational forms to elicit desired outcomes.

Conclusion

This study was modeled after two previous studies (DeKuiper et al., 1993; Lang et al., 1992) but used well elderly women living independently as subjects rather than persons who are institutionalized. It extended the research to include self-perceived rest periods after lower-extremity exercise and heart rate response in addition to the number of repetitions completed and duration of participation. Results substantiate the findings of the two previous studies, indicating that varying occupational forms result in differences in performance. Subjects in the materials-based condition completed significantly more repetitions than subjects in the imagery-based and rote exercise conditions. The self-perceived rest period was of longer duration after the materials-based condition; however, it was not proportionally longer given the greater number of repetitions completed. Posttask heart rates were not different among the three groups. Traditional occupational therapy recognizes the importance of occupations that evoke meaning and create purposes to guide involvement in therapy (AOTA, 1979; Levine & Brayley, 1991). Further research on occupational forms can provide important empirical support for the use of meaningful, purposeful occupations as therapeutic agents of change.

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