A Comparison of Performance Measures of an Added-Purpose Task Versus a Single-Purpose Task for Upper Extremities

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Key Words: purposeful activities

Purposeful activity in the form of a secondary or added-purpose task has been recognized as an effective means of distraction or dissociation and thus may greatly affect primary task performance (Affleck et al., 1984; Riccio, Nelson, & Bush, 1990). Embedding of the primary task (which in many cases is exercise) within an occupational or goal-directed activity is conducted in an effort to increase the performance of the primary task by directing the person’s attention to an objective or outcome other than the specific muscle or extremity function required to perform the primary task (Bloch, Smith, & Nelson, 1989; Kircher, 1984; Steinbeck, 1986; Thibodeaux & Ludwig, 1988; Yoder, Nelson, & Smith, 1989). When performance of a primary task, such as exercise, is coupled with a secondary, goal-directed activity, such as stirring cookie dough, this new task is referred to as an added-purpose task. Exercise is considered a single-purpose task. When exercise is performed as a single-purpose task, the person’s attention is directed toward the specific muscle or extremity required to perform the desired motion (Nelson & Peterson, 1989; Steinbeck, 1986). It is believed that the added-purpose task may improve exercise performance. If this is true, then a greater number of repetitions or a longer duration of performance should be obtained with an added-purpose task as opposed to a single-purpose task. Numerous authors have employed a variety of approaches in an effort to understand the value of the added-purpose task.

Kircher (1984) compared the performance of 26 women on jumping rope to jumping in place without a rope in terms of heart rate and exercise duration. Upon stopping at a predetermined level of perceived exertion, the subjects who jumped rope had a significantly higher heart rate \( (p < .001) \) than did the subjects who jumped in place without a rope. Kircher concluded that exertion and fatigue were perceived to be less when jumping with a rope than without a rope and argued that these results indicated enhanced motivation in the subjects who engaged in the jump rope activity. In this study, jumping without a rope might be thought of as a single-purpose task, whereas jumping with a rope might be considered to be an added-purpose task.

Steinbeck (1986) hypothesized that persons would be distracted and therefore perform longer when an activity was goal directed or had added purpose. For the added-purpose conditions, 30 subjects were asked to participate in a bulb-squeezing exercise that resulted in the suspension of a table-tennis ball and in a pedaling exercise that resulted in the operation of a drill press. These conditions were compared with conditions in which the same 30 subjects performed bulb squeezing that did not result in the suspension of the table-tennis ball suspension and pedaling that did not result in the operation of a drill press. The frequency of repetitions in both of the added-purpose conditions exceeded those of the pure exercise, or single-purpose, conditions.
Bloch et al. (1989) replicated the research project done by Kircher (1984). Their study went beyond Kircher's design by including questions concerning how subjects felt about the jump rope activities. They also departed from the terminology of purposeful and non-purposeful activity and adopted the terms added-purpose and single-purpose activity. Thirty women, ages 18 to 31 years, jumped with a rope one day and jumped in place on another day in a counterbalance design. Each subject stopped jumping when she reached the perceived exertion rate of very hard on the Borg Scale of Perceived Exertion (Borg, 1982). Jumping with a rope was designated as the added-purpose activity, and jumping without a rope was the single-purpose activity. The exercise heart rate was significantly higher \( (p = .01) \) for jumping with a rope than for jumping without a rope. The mean exercise heart rate for jumping with the rope was 96.17 beats per min; for jumping without a rope, 82.50 beats per min. Jumping duration approached significance \( (p = .06) \). Twenty of the 30 subjects jumped longer without a rope. There were no differences for preference of jumping with or without a rope.

Yoder et al. (1989) designed a task that combined a rotary arm exercise with the added purpose of stirring cookie dough and compared it with a task designed to elicit the rotary arm exercise without added purpose. Thirty elderly female nursing home residents were randomly assigned to one of the two tasks. Results indicated that the added-purpose condition elicited significantly more exercise repetitions than did the single-purpose condition \( (p < .05) \). The mean exercise duration for the added-purpose group was 6.06 min; for the single-purpose group, 2.49 min.

Riccio et al. (1990) investigated adding purpose through imagery. Twenty-seven subjects were asked to imagine themselves reaching up to pick apples or reaching down to pick up coins. All the subjects received imagery as well as control conditions in a counterbalance design. There were a significantly greater \( (p < .05) \) number of repetitions of the reaching up to pick apples than of the reaching up control condition. The results for the reaching down to pick up coins were not found to be significantly greater than the reaching down control condition.

The present study is similar to these previous studies. It examined the use of an added-purpose task to increase the intensity and duration of task performance. Occupational therapists often couple exercise with a secondary task, believing that the fulfillment of additional goals will provide meaning or be distracting and subsequently improve exercise performance. For this reason, the first author designed an added-purpose task that coupled upper extremity exercise with bell ringing in order to determine if this simplest of task modifications would add purpose to an exercise situation and thus improve performance. Additionally, heart rate, target heart rate, and rate of perceived exertion were monitored. These variables, although a part of the exercise situation, are not usually monitored in the restorative rehabilitation setting.

The purpose of this study was to contrast the performance of those subjects instructed to participate in an upper extremity added-purpose task (i.e., ringing a bell) with that of subjects instructed to participate in an upper extremity single-purpose task (i.e., moving a weighted box). The dependent variables examined in this study were exercise heart rate, task duration, and the number of repetitions performed.

**Method**

**Subjects**

Thirty subjects, 15 men and 15 women, all employees at a Department of Veterans Affairs Medical Center, volunteered for this study. On completion of demographic questionnaires and informed consent forms indicating that they had no known heart, lung, orthopedic, or arthritic abnormality, the subjects were randomly assigned in a stratified manner, based on age and sex, to the added-purpose task group or the single-purpose task group. The consent forms also advised the subjects to inform the first author if they experienced any discomfort, such as dizziness, headache, shortness of breath, or undue fatigue, or if they wished to discontinue the experiment. The mean age of the subjects in the added-purpose task group was 45.00 years \( (±6.94) \) and in the single-purpose task group, 45.13 years \( (±7.63) \). Of the 30 subjects, 21 were nonsmokers, and none were currently involved in vigorous upper extremity exercise programs.

**Apparatus**

The upper extremity apparatus was constructed to provide identical work loads in order to contrast subjects participating in the upper extremity added-purpose task with subjects participating in the upper extremity single-purpose task. The apparatus included a base, an angle frame, a bell mechanism, and a weight box (see Figure 1).
Subjects in the added-purpose group were told that their task was to ring the bell as many times as possible by moving the weight box along the angle frame, stopping when they thought they had reached a point of working very hard (17) (as measured on the Borg Scale). Subjects in the single-purpose group were told that their task was to fully extend and flex their elbows in order to move the weight box as many times as possible, stopping when they thought they had reached a point of working very hard.

During task performance, the apparatus was clamped to a work table for stability. For purposes of this study, the height of table was set at $29\frac{1}{2}$ in. The incline of the angle frame, which could be adjusted to decrease or increase the amount of resistance, remained at 60° for this study. Furthermore, up to 30 lb of resistance could be added to the weight box. For purposes of this study, both upper extremity tasks were performed at 10 lb of resistance. The weight box slides along the angle frame. A removable L-shaped metal rod bell ringer is attached to the weight box. The L-shaped metal rod bell ringer was adjustable to allow for variations in the subjects' arm lengths. The weight box is designed to be pushed along the angle frame with or without the L-shaped metal rod attached. A small plywood box was constructed to securely cover and hide the bell mechanism during the single-purpose task (see Figure 2).

Procedure
A stratified random assignment technique was used to assign the subjects, according to age and sex, to either the added-purpose task group ($n = 15$) or the single-purpose task group ($n = 15$). The subjects were told that the purpose of the study was to evaluate the effects of upper extremity tasks on heart rate. The added-purpose task group performed the added-purpose task and then, after a 24-hr interval but within a 2-week period, repeated the task a second and a third time. The single-purpose task group performed the single-purpose task using the same format. The number of repetitions, task duration, and exercise heart rate were recorded for each subject in each task group.

A review of the literature revealed that upper extremity work can cause a greater increase in heart rate than can work with the lower extremities (Chung, 1983; Schwade, Blomqvist, & Shapiro, 1977). Therefore, a target heart rate $[(220 - \text{age}) \times 85\%]$, calculated for each subject, provided an upper boundary for exercise intensity. Maintenance of an exercise heart rate at or below this boundary was designed to decrease cardiac risk and was appropriate for this study, as the subjects had no known cardiac abnormalities.

The subjects were asked to work until their level of perceived exertion reached very hard on the Borg Scale. The Borg Scale is a 15-grade scale for ratings of perceived exertion and has been widely used by researchers to evaluate subjective responses of individuals during exercise (Borg, 1982; Noble, 1982; Pandolf, 1982; Roberson, 1982).

The technique to be used during testing was explained to each subject prior to the beginning of the task. Each subject received the same commands and technical cues regardless of the task. Subjects were attached to the electrocardiogram (EKG) and positioned so that they could not observe the monitor during task performance. They were then seated in front of the task apparatus in a straight-backed chair with approximately 10 in. between the table edge and their navel. A 3-in. wide strap with a touch-fastener closure was placed across the chest and secured to the back of the chair to restrict the subjects’ posture and to allow only active shoulder and arm movements. Subjects placed their right and left hands on the plastic handle grips of the weight box. Subjects in the added-purpose group were told that their task was to ring...
the bell as many times as possible by moving the weight box along the angle frame. Prior to the single-purpose task, the bell mechanism of the task apparatus was covered to eliminate the element of added purpose. Subjects in the single-purpose group were told that their task was to fully extend and flex their elbows in order to move the weight box along the angle frame as many times as possible. The subjects' resting heart rates were recorded.

The researcher (the first author) demonstrated the rate at which to perform the task through finger snapping (approximately 65 rpm). Subjects were told to begin work, and the stopwatch started. The subjects were advised during task performance of the need to slow down or speed up their rate. The number of repetitions for each subject was counted with the use of a manual counter or by the researcher if the EKG monitor indicated that their target heart rate had been reached. At the point of task cessation, the stopwatch was stopped and the subjects' exercise heart rates were recorded. The duration of task performance and the number of repetitions were also recorded.

On completion of each trial, the subjects were told the number of repetitions performed and the duration. On completion of the third trial, the subjects were asked, “What kept you going?” and “Did you count?”

**Instrument**

Heart rate was monitored with the Marquette Computer Assisted System for Exercise (Marquette Electronics Inc., 1983). The electrodes were attached to cleansed and abraded skin to form a 3-lead (aV_R, aV_L, aV_T) chest hookup.

**Results**

The means, standard deviation, and median scores for the added-purpose task group and the standard-purpose task group across trials for the dependent variables (number of repetitions, duration of task performance, and exercise heart rate) are presented in Table 1. To determine whether persons in the added-purpose group performed the task longer, more times, and at a higher heart rate than persons in the single-purpose group, a 2 × 3 (Group × Trial) multiple analysis of variance (MANOVA) with repeated measures on the second factor (Trial) was computed (SAS, Inc., 1983). The results of the MANOVA indicated no significant overall group effect [F(3, 26) = 0.22, p > .05], a significant overall trial effect [F(6, 108) = 3.02, p < .01], and no significant Group × Trial interaction effect [F(6, 108) = 1.00, p > .05]. These results indicated a significant overall effect for trials, which necessitated computation of follow-up univariate analyses of variance for each dependent variable. These analyses indicated no significant Group, Trial, or Group × Trial interaction effect (p > .05) for exercise heart rate or task duration. The univariate analysis of variance for number of repetitions indicated no significant effect for group (p > .05) and no significant Group × Trial interaction effect (p > .05). However, there was a significant main effect for trials (p < .05).

A Tukey (McClave & Dietrich, 1985) post hoc analysis indicated that there was a significant difference in number of repetitions between Trials 1 and 2. The mean for the first trial was 160.67 repetitions, and the mean for the second trial was 190.50 repetitions. The results of this study indicated that there were no significant differences between the added-purpose group and the single-purpose group in any measure of task performance (i.e., number of repetitions, duration, exercise heart rate). In addition, repetition of the task across the trials had virtually no effect on task performance. The one exception was that performance increased for number of repetitions for the combined groups from Trial 1 to Trial 2.

**Discussion**

The results of this study indicated that the added-purpose task (i.e., ringing a bell) did not provide sufficient additional distraction or meaningfulness for the subjects in the added-performance task group, such that they would

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**Table 1**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td><strong>ADDED-PURPOSE TASK GROUP (n = 15)</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Number of repetitions</td>
<td>M 145.60</td>
<td>181.46</td>
<td>171.06</td>
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<tr>
<td></td>
<td>SD 77.17</td>
<td>130.22</td>
<td>101.71</td>
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<tr>
<td></td>
<td>Median 143.00</td>
<td>157.00</td>
<td>165.00</td>
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<tr>
<td>Duration (sec)</td>
<td>M 158.00</td>
<td>195.93</td>
<td>172.20</td>
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<tr>
<td></td>
<td>SD 84.09</td>
<td>126.05</td>
<td>99.39</td>
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<tr>
<td></td>
<td>Median 121.00</td>
<td>161.00</td>
<td>162.00</td>
</tr>
<tr>
<td>Exercise heart rate (beats per min)</td>
<td>M 129.99</td>
<td>139.53</td>
<td>135.86</td>
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<tr>
<td></td>
<td>SD 18.68</td>
<td>16.20</td>
<td>14.45</td>
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<tr>
<td></td>
<td>Median 134.00</td>
<td>132.00</td>
<td>131.00</td>
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<tr>
<td><strong>STANDARD-PURPOSE TASK GROUP (n = 15)</strong></td>
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<td></td>
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<tr>
<td>Number of repetitions</td>
<td>M 175.73</td>
<td>189.53</td>
<td>194.33</td>
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<tr>
<td></td>
<td>SD 84.92</td>
<td>69.92</td>
<td>70.61</td>
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<tr>
<td></td>
<td>Median 164.00</td>
<td>178.00</td>
<td>172.00</td>
</tr>
<tr>
<td>Duration (sec)</td>
<td>M 195.80</td>
<td>196.26</td>
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<td>SD 91.35</td>
<td>67.39</td>
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<tr>
<td></td>
<td>Median 178.00</td>
<td>181.00</td>
<td>189.00</td>
</tr>
<tr>
<td>Exercise heart rate (beats per min)</td>
<td>M 134.93</td>
<td>139.13</td>
<td>136.46</td>
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<tr>
<td></td>
<td>SD 19.81</td>
<td>17.00</td>
<td>18.41</td>
</tr>
<tr>
<td></td>
<td>Median 133.00</td>
<td>145.00</td>
<td>135.00</td>
</tr>
</tbody>
</table>
Tasks that add purpose through product outcome have added-purpose of stirring cookie dough and making cookies. Subjects in the added-purpose group demonstrated significantly more exercise repetitions than did the pure exercise condition with no added purpose. However, Thibodeaux and Ludwig (1988) combined exercise with the added purpose of sanding a cutting board that the subjects could keep when completed. The single-purpose task consisted of the same subjects sanding a board that they were not allowed to keep. Their findings were consistent with the present study; there were no significant differences between the groups in task duration or exercise heart rate.

During the debriefing, subjects in the added-purpose group did indicate that ringing the bell had been fun, thus, motivating them to continue. These comments are consistent with comments reported by Thibodeaux and Ludwig (1988), who reported that subjects indicated that they enjoyed the entire process of making a cutting board significantly more than they liked sanding a piece of wood.

In the present study, neither task produced a product and both tasks may have been perceived as purposeful. Trombly (1982) has suggested that although exercise may not be considered product oriented, it may still be considered a purposeful task. Here the attempt to increase the activity of subjects by extending the point that they believed they were working very hard was not successful.

One of the methodological precautions used in the present study was to stop an exercise trial when 85% of maximum heart rate was reached. The exercise trials of 3 subjects in the added-purpose group and 8 subjects in the single-purpose group were discontinued prior to the point where these subjects reported working very hard. This is a limitation of the study. The fact that this unexpected situation occurred with such frequency for subjects in both groups might lead one to speculate that subjects were highly motivated to perform the tasks. Inspection of the means and standard deviations in Table 1 further suggests that there were wide individual differences in performance of individual subjects within both groups.

The present study examined the number of repetitions, task duration, and exercise heart rate for subjects engaged in a resistive upper extremity added-purpose task. It was believed that such a task could be used for restoration purposes in a rehabilitation setting. The results indicated that this task, although labeled added purpose, was no more effective than the single-purpose task. These results, coupled with the results from past research, suggest several implications for occupational therapists with regard to the selection and design of rehabilitative tasks. Occupational therapists should solicit statements of purpose or meaning from patients performing rehabilitative tasks. This input should be used to determine those tasks that will facilitate improved performance for the patient. For some patients, added-purpose tasks may be most effective. For others, the added-purpose task may need to produce a product to be effective. For still others, simple exercise repetitions may result in longer exercise sessions. The patients' input should also be used to design new tasks. Generalizations regarding the relative purposefulness of various tasks or how the nature of the task can be manipulated to influence perceived exertion appear to be evasive at this point in time. Certain assumptions or beliefs held by occupational therapists regarding the relative effectiveness of single-purpose and added-purpose tasks may be less effective in selecting and designing rehabilitative tasks than direct patient input.

For future research, replication of added-purpose tasks that can increase heart rate and the length of exercise sessions will help to identify those specific tasks that improve performance. Also needed is empirical support for the effectiveness of the added-purpose task on the exercise performance of persons with disabilities.

Acknowledgments
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References


