Motivation as a Factor of Perceived Exertion in Purposeful versus Nonpurposeful Activity
(cardiac telemetry, occupational therapy theory, exercise, competence)

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Perceived exertion during the performance of purposeful and nonpurposeful activity was studied in 26 women. The subjects acted as their own controls in the performance of both kinds of exercise. The two exercises were jumping rope, defined as a purposeful activity, and jumping in place without a rope, defined as a nonpurposeful activity. In each activity the subjects exercised to reach the subjective point of "very hard work" on the Borg Scale of Perceived Exertion. Duration and cessation of exercise were entirely controlled by the performers. Heart rate responses during and immediately after cessation of exercise, measured by electrocardiographic telemetry, and duration of exercise in seconds were compared for the two types of exercise. Results showed that heart rate increase at a given rate of perceived exertion was significantly higher (.001) for jumping rope. This raises the possibility that workload was inadvertently perceived by the performers to be greater in nonpurposeful activity and provides support for the hypothesis that purposeful activity serves as an intrinsic motivator to the performer.

A central hypothesis in occupational therapy is that patient motivation is important (1, 2). One way of increasing patient motivation is to make the treatment modality purposeful (2). Purposeful activity refers to tasks that are goal directed, focusing attention to an object or outcome (3). The goal may be fun, as in play (3); enjoyment; or self-expression, such as the experience of rhythm in dance (4). Action with feedback involving an object is often a component of purposeful activity (5). Such an activity analysis is consistent with jumping rope, an activity that uses skill and rhythm and interaction with an object as its focus or purpose.

Theorists assert that the uniqueness of occupational therapy lies in its use of self-initiated purposeful activity (6) and that humans can influence the state of their health through action and occupation (7). Purposeful activity leads to mastery of the environment and a sense of competence and self-worth (5, 8). Improvement of dysfunction occurs with involvement in activity or occupation (9). An adaptive motor response is more likely to be gained when the person is not consciously focusing on the task (3, 10). Trombly and Scott (11) emphasize in activity analysis that automatic movement is operant on a subcortical level, but attention directed to the movement itself involves greater cortical control. A well-known obstacle to successful motor learning is cortical interference by the learner: the teacher's task is to discourage conscious focus on movement (12).

Many authors have expressed a need for a critical look at the concept of purposeful activity, especially when it relates to the use of exercise in occupational therapy for physical disabilities. Huss (13)
expressed concern that modern occupational therapists are moving away from the use of purposeful activity in their treatments. Trombly (14) expressed concern that an unclear and narrow definition of purposeful activity excludes exercise, although exercise is often the treatment of choice in effectively achieving goals. English and others (15) asserted that retraining techniques in occupational therapy for physical disabilities should include but not be limited to purposeful activity. Reilly stated "for us, in occupational therapy, the most fundamental area for research is, and probably always will be, the nature and meaning of activity." (16, p 208) Zurchauer expressed the need to explore "what activities do" in her general session address at the 63rd AOTA Annual Conference in Portland. Three studies were published in the past 10 years that critically examined aspects of activities used by occupational therapists in treatment (17-19), but none of these studies is similar to this project being reported.

The purpose of this study was to determine whether purposeful activity provides intrinsic motivation to exercise performance. Real levels of exercise, measured by heart rate increase at the same perceived exertion level, were compared in two similar exercises selected as purposeful (jump rope) and nonpurposeful (jumping without a rope). Jump rope could be described as "fun" and, in doing it, one's mental focus is likely to be on the rhythm and synchrony of the upper and lower extremities and manipulation of an object (3, 4). In the jumping-without-a-rope activity, the mental focus is likely to be on jumping itself and physical exertion. It is assumed that an activity must have meaning to the performer to be purposeful. In rope jumping, purpose or meaning is derived from the enjoyment the performer experiences from rhythm and skill competence, including manipulation of and interaction with an object. Maximal heart rate and total exercise time at the end of each exercise were the parameters used to test whether, at the same level of perceived exertion, real levels of exertion were equal.

Methods

Subjects. Twenty-six normal females, aged 19 to 37, with a mean age of 26.2 years, were the subjects of this study. A 27th person was disqualified because of error in method, and her scores were excluded from the data analysis. Volunteers were selected as subjects if they 1. reported that they enjoyed competence at jumping rope as children, and 2. demonstrated competence by performing the activity in a pretest for at least 1 minute. This selection process was used in order that jumping rope would be an appropriate activity for each of the subjects, consistent with activity selection in occupational therapy (2, 8). It is assumed that appropriateness of activity is inherent to its being purposeful to the performer. All subjects were without heart, lung, or orthopedic dysfunction that might be aggravated by the vigorous exercise of jumping.

Instrumentation. Fifteen of the 26 subjects were tested with a Hewlett-Packard telemetry unit, an electrocardiograph (EKG) recorder, and a stopwatch at one facility, and 11 subjects were tested with a Bio-Design telemetry unit, Tektronix EKG recorder, and another stopwatch at another facility. This change in facilities occurred because the researcher moved to another city before the project was completed. Since the measurement procedure involved simply counting the number of QRS complexes (represents heart rate on EKG) within a minute and recording time in seconds, this change in instrumentation is not considered to detract from the validity of the study.

Because there is a potential for margin of error in the calculations of heart rate from rhythm strips, particularly in determining exact distance between QRS complexes, test-retest reliability was recalculated on ten records. The correlation coefficient (r) was .94.

An earlier pilot study with ten subjects demonstrated significance at the .05 level for increase in heart rate over resting in the jump rope activity and also for the duration of time that each subject jumped with the rope. The Borg Scale of the Rate of Perceived Exertion (RPE) (20) was used in this experiment to assist the subjects in determining when to stop jumping (Figure 1).
Skinner and others (21), determined the validity and reliability of the Borg scale. For each subject, they compared RPE responses to a progressive exercise test and those responses given to random changes in workloads, obtaining no significant differences. Positive reliability was determined by using each protocol to test each subject twice. In the progressive test, the \( r \) value was .80, and in the random test, it was .78 for RPE.

**Procedures.** After obtaining informed consent, the subjects were randomly assigned to two groups of equal size in order to rule out the effect of testing order (such variables as self-competition and loss of enthusiasm in the project). One group performed the jumping rope activity before they performed the jumping exercise without a rope (Group A); the other group jumped without a rope first (Group B).

Each subject was attached to EKG telemetry. Three electrodes were attached at midsternum and under the right and left arms to achieve a modified Lead 1. Subjects were positioned so that they could not observe the measurement instruments. The subjects were not informed of the purpose of the experiment.

In the jump rope exercise, the style of bilateral double jumping was demonstrated by the experimenter. In the no-rope exercise, the subjects were instructed to "jump at a similar pace to jumping rope," and "jump high enough to clear a rope if you had one." Further, they were instructed to hold their upper extremities as if they really had a rope in order to use musculature and expend energy comparable to rope jumping. The subjects were told not to move their arms. (This was done so that they would not imitate the rhythm and synchrony of the purposeful rope-jumping activity.)

Before jumping, the subjects were shown a copy of the Borg scale (see Figure 1) and instructed to "jump until you feel that your body is working very hard"—level 17 on the scale." Heart rate was recorded just before the exercise, at 1-minute intervals during the exercise, and immediately after the subject stopped jumping. Length of time that each subject jumped was measured with a stopwatch.

The testing was done in two sessions, one for each exercise, on different days to control for fatigue in the performance of the second exercise.

**Data Analysis.** A one-tailed t-test for correlated measures was used to compare performances in the two exercises. The \( t \)-test was used because of the small sample of normal people. Correlated measures were used because each subject's heart rates and exercise times in both exercises were paired for comparison. One-tailed was used because a directional difference was predicted, that is, mean heart rate increase for jump rope was predicted to be greater than it would be with no rope. To compare the performances of Group A to Group B, a two-tailed \( t \)-test for uncorrelated measures was used because the groups were viewed independently and were not expected to differ (for testing order only). A \( t \)-test was used for each 7-minute interval for the first 3 minutes. (Not enough jumpers performed longer than that to warrant data analysis.)

**Results**

It was found that heart rate increase at a given RPE was significantly higher for jumping with a rope than without (\( \alpha = .001 \)) (Table 1). Heart rate increase from resting baseline in the two exercises is illustrated in Figure 2.

It appeared that the subjects performed longer in the rope jumping exercise, although this was not statistically supported (Table 1). Exercise duration is illustrated in Figure 3.

A comparison of heart rate on 1-minute intervals during the subjects' performances in the two exercises was analyzed and showed no significant difference in the amount of increase of heart rates. The difference between the mean heart rate increases of the two exercises was 4.2 beats/min during the first minute; 4.7 during the

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**Table 1**

<table>
<thead>
<tr>
<th></th>
<th>Minutes</th>
<th>SD</th>
<th>( t )</th>
<th>( p )</th>
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<tr>
<td><strong>Heart Rate Increase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>With rope</td>
<td>103.19</td>
<td>24.33</td>
<td></td>
<td></td>
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<tr>
<td>Without rope</td>
<td>92.04</td>
<td>27.83</td>
<td></td>
<td></td>
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<tr>
<td>Difference</td>
<td>11.15</td>
<td>16.84</td>
<td>3.31</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Exercise Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With rope</td>
<td>187.96</td>
<td>176.71</td>
<td></td>
<td></td>
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<tr>
<td>Without rope</td>
<td>146.12</td>
<td>140.73</td>
<td></td>
<td></td>
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<td>41.84</td>
<td>110.28</td>
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<td>ns</td>
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second minute; and 2.6 in the third minute of exercise.

A comparison of heart rates and exercise times of Group A and Group B showed no significant difference; order of testing did not have an effect on outcome.

Discussion
The results of several researchers demonstrated that heart rate has a high positive correlation with RPE (22-25) and that subjects gave similar RPE scores to work presented in random tests to that presented in progressive exercise tests (21, 26).

This study is unique because it demonstrates that heart rate at a given rate of perceived exertion is significantly higher in the performance of a purposeful activity than of a nonpurposeful one in normal subjects. This is interesting when compared to Borg and Lindholm's (23) results: Heart rate at a given RPE was higher in young adults than in middle-aged men. In another paper, people with vaso-regulatory asthenia (weakness) were reported to give lower RPE ratings in relation to heart rate than a healthy control group. The same result was found for people with arterial hypertension, but people with coronary heart disease rated exertion to be higher in relation to heart rate, compared to the normal controls (27). No difference was found in maximal values of RPE in a comparison of lean and obese subjects (28).

"Task aversion" and "motivation" are considered as factors of relative fatigue in a proposed model (29). The results of this study imply that exertion level is perceived to be less in purposeful than in nonpurposeful activity. A person may not perceive fatigue as readily when his or her attention is focused on an appropriately selective activity. Decreased fatigue perception is assumed to indicate motivation. This provides support to the occupational therapy theory that purposeful activity (that which is goal directed and uses action with feedback involving an object (3, 5)) may provide an intrinsic motivator to the performer (2).

Various factors potentially influencing perception of exertion have been examined. Results of experiments suggest that there are
two factors operant in the perception of exertion during physical work. One factor is "local" feelings of strain in the working muscles and joints, and the other is a "central" factor of sensations from the cardiopulmonary system (30-32). It was demonstrated that exertion was perceived to be higher for running than for walking at low velocity and that the reverse was true for high velocities, presumably because of differences in perception of local muscle strain at different paces (30). Local muscular factors were found to be the predominant, perceived sensation for cycling, whereas central cardiopulmonary factors were perceived as the primary sensation for treadmill walking, and perceived exertion generally decreased with conditioning (32).

A limitation of the current study is posed by the possibility that some of the performers perceived the rope jumping and the ropeless jumping differently, responding to local factors in one and to central factors in the other (30-32). In this critique, it must be reiterated that several studies indicate a high positive correlation of heart rate and RPE (22-23) and that the lower extremities were exerted in much the same manner in both exercises. The nature of the independent variable may be challenged by some readers. It may appear that rhythm or preference (liking the activity) were the independent variables instead of purposefulness. It can be argued that both rhythm and preference are components of the purposeful activity of rope jumping as initially defined in this article.

Another limitation of this study is the small sample size, which means that the study may not lend itself to generalization. The wide variability in exercise time scores arising from the small sample may be a factor and one reason the results did not reach statistical significance, since it appears that the performance time was longer with the rope (Figure 3).

The first implication this project has for occupational therapy treatment is basic: Purposeful activity is more motivating to a patient/client than nonpurposeful activity. (This assumes that motivation is the factor that causes people to perform longer in a purposeful activity.) However, applying this factor to clinical practice is complex. The individual's preference for purposeful activity must always be considered; for some people, "straight" exercise is purposeful (14) (that which has no other goal than what is gained directly from exercise). Graded exercise, end-range stretching, repetitive movements, and programs for improving vestibular and motor control are important components of many therapeutic programs developed by physical disability occupational therapists. It is not realistic to expect such programs to include purposeful activity 100 percent of the time. However, the therapist should creatively incorporate purposeful activity into treatment whenever possible to achieve the desired goal.

Purposeful activity has a wide interpretation. For example, an object strategically placed can divert attention away from painful movement or impaired motor control and toward the goal of reaching and grasping. The use of music and sequencing of range of motion exercises into a graceful routine can direct the mind away from repetitive motion and pain, and toward rhythm and expressive movement, thus increasing motivation and potential compliance in a home program for some patients. High loads of work motivated by purposeful activity can be beneficial to increasing muscle strength and endurance, such as in the case of a paraplegic individual.

Another application to treatment is the use of the Borg Scale of Perceived Exertion (Figure 1) to provide a self-determined goal for enhancing motivation. Charlotte DeRenne, my colleague, suggested that cardiac patients may not perceive their own exertion level accurately if they are involved in a purposeful activity. Clinicians need to be aware of this danger when working with cardiac patients. Also, the patients should be educated about this danger so that they can manage their activity level wisely at home and at work.

The results of this study can be applied to increase productivity in labor and industry. A person, not perceiving fatigue as readily in purposeful activities, would tend to be more motivated in work performance. An example would be to set up jobs on an assembly line specifically to allow frequent goal achievement and inherent reinforcement by adding increased purposeful motion to each job component.

Finally, this study might serve as a model for doing clinical research comparing activity and exercise. This research design might also be used for comparing workloads in occupational therapy work-simplification techniques to typical work methods. A metabolic study would also be useful to compare fatigue in muscles taxed by concentration in a nonpurposeful activity to muscles used in a purposeful activity. It would also be interesting to test the validity of the perceived exertion scale with cardiac patients.
Summary
It was found that a group of 26 women were performing harder, as evidenced by a significantly greater heart rate increase, at the cessation of a purposeful rope jumping activity than at cessation of a purposeless jumping exercise of similar exertion. The women performed in each exercise to reach the same level of exertion on the Borg Scale of Perceived Exertion. No significant difference in the duration of time the subjects performed was found, possibly because of wide variability in scores.

The results of this study lend credence to the occupational therapy theory that purposeful activity is motivating and rewarding to the learner. The study also adds to the body of knowledge of perceived exertion: Motivation should be a considered variable in the perception of workload. The potential applications of these results to occupational therapy practice were discussed.

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References