Improved Productivity Through Purposeful Use of Additional Template for a Woman With Cortical Blindness

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Key Words: brain injuries • prevocational training

A single-subject study with an ABAB design investigated an adaptation of a work activity through the purposeful use of an additional template to improve productivity for a woman with cortical blindness resulting from anoxic brain damage. The activity required the subject to outline brackets (as parts of a handi-rack woodwork project) by tracing a template on a piece of pine board. During the baseline phase of the study, the subject used one template to outline the brackets. During the intervention phase, the subject used an additional template after receiving a brief training in its use. Productivity was measured by the number of potentially usable outlined brackets. Data analysis revealed that in the intervention phases, productivity improved significantly and accuracy increased. The application of tapping the subject’s intact sensory system was valuable for determining her vocational potential. The rationale of using an additional template to improve productivity was explained by the theory of affordance.

Occupational therapists are specialists in selecting and adapting purposeful activities to maximize a person’s task performance and rehabilitation potential. Adaptation of activities is especially essential in prevocational or vocational training. For persons with brain damage who exhibit severe motor, executive, cognitive-perceptual, and psychosocial deficits, overcoming deficits through adaptation of activities can facilitate task performance. Examples of compensatory tools, ergonomic adaptations, and training strategies (role-playing, job simulation, and domain-specific training) are available (Deaton, Poole, & Long, 1987; Haase & Peissig, 1990; Parente, Stapleton, & Wheatley, 1991).

Antecedent controls, such as checklists, written instructions, and cueing cards, have been successfully used to compensate for deficits in the areas of memory, initiation, organization, and problem solving to improve speed and quality of task performance (Burke, Zencius, Wesolowski, & Doubleday, 1991; Wehman et al., 1989; Zencius, Wesolowski, Burke, & McQuade, 1989).

Few studies, however, have systematically analyzed the benefits of using compensatory tools to improve productivity. Deaton et al. (1987) suggested the use of mechanical guides on workshop equipment to enable persons with tremors or visual difficulties to compensate for their physical deficits. Chase (1989) described the use of jigs as an equipment adaptation to improve workshop performance and productivity and to enhance motor functions for a group of persons with severe physical disabilities. Wehman and colleagues (1989) mentioned some ergonomic strategies to compensate for the task performance of two clients, one exhibiting right hand ataxia and blurred vision in the left eye, the other exhibiting visuoperceptual deficits. None of the above studies quantitatively evaluated the effectiveness of the mechanical adaptation as part of the client’s vocational performance.

This study investigated the effectiveness of the purposeful use of an additional template in a tracing activity for a woman with cortical blindness resulting from anoxic brain damage. Effectiveness was quantified by her productivity. An ABAB single case reversal experimental design was used. This design, which involved collecting data in two baseline phases and two intervention phases, is more valid than an ABA design (Barlow & Hersen, 1984).

Method

Subject

The subject was a 36-year-old single woman who sustained cerebral anoxia associated with postoperative complications from a proctocolectomy 17 years ago. Two days after surgery (i.e., construction of ileostomy), she experienced a prolonged generalized convulsion followed by recurrent seizures within a few days. She lapsed into a coma for 2 weeks. The seizure activities were se-
were enough to result in hypoxic ischemic cerebral injury. She began to recover neurologically after 1 month of hospitalization and approximately 1 month of rehabilitation. She was discharged home but on three occasions required psychiatric hospitalization for agitated psychotic behavior. The psychiatric diagnosis was organic delusional syndrome secondary to anoxia with a long-standing history of partial complex epilepsy.

**Neuro-Ophthalmological Examination**

The subject had a pair of prescription glasses with lenses that were set at -5.00 + 0.25 x 48 in the right eye and -4.75 + 0.75 x 140 in the left eye, but did not respond to any questioning that required vision. She did not have total loss of vision. She had relatively preserved peripheral vision primarily to the right and to a small extent to the left in both eyes. The absence of central vision and vision down and to the left is consistent with the definition of cortical blindness (Gelesia, Bushnell, Toleikis, & Brigell, 1991). Her auditory and tactile recognitions were intact. She was unable to recognize faces or letters, but did recognize voices and letter-shaped objects placed in her hand. The neuro-ophthalmologist concluded that her blindness was a fixed deficit and recommended teaching her to use sensory systems other than visual.

Neuropsychological assessment revealed memory and cognitive processing deficits, significant learning and memory deficits, and language and verbal reasoning deficits (see Table 1). The subject demonstrated impairment in acquiring information over repeated learning trials. Her attention deteriorated dramatically as task complexity increased. Other deficits included right-left orientation disturbance, body parts impairment, finger agnosia, and apraxia for symbolic gestures. In addition, she tended to confuse reality with fantasy, particularly when listening to the radio or television or when in a high stimulus environment. She became nervous and very distractable in these situations.

**Materials**

Materials used in this study were 6 pieces of pine board, each measuring 4.7 in. by 24 in. by ¾ in. (12 cm by 61 cm by 2 cm), two templates of the bracket, and a pencil. The bracket template was triangular with a base of 6.5 cm, a height of 11 cm, and a thickness of 2 cm.

**Procedure**

The activity required the subject to outline brackets by tracing a template with a pencil onto a pine board (see Figure 1). The tracing activity was part of the assembly line task for the handi-rack woodwork project. The subject had no prior experience in working with a similar woodwork project.

Once the subject outlined the first bracket, she was verbally cued to outline the second bracket by moving the template along the board. This repetitive procedure continued until she reached the end of the pine board. After she finished the first pine board, she was cued to complete the next pine board until all 6 boards were finished. This is the standard way for a woodworking manager to teach clients how to outline brackets. Each piece of pine board could yield 7 brackets; the 6 pieces of pine board thus could yield 42 outlined brackets.

A radial saw was used to separate the outlined brackets and a jig saw was used to cut the parts to shape. A minimum of 1.3 cm space between the base of each outline was required for the radial saw to separate them. The criteria for counting an outlined bracket as a useful product were (a) the space between the bases of each outlined bracket had to be wider than 1.3 cm.; (b) 7 outlined

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**Figure 1.** Bracket as part of handi-rack.
brackets had to be obtained from each board length, which meant that the space between 2 outlined brackets could be no more than 2.6 cm; and (c) the pencil mark for each outlined bracket had to be clear and continuous.

The subject performed the tracing activity daily, Monday through Friday, in a low stimulus therapy room as part of prevocational training. The activity was scheduled to last for only 15 min because the subject's performance in other activities suggested that this was a reasonable time expectation for her to maintain vigilance without delusional expressions and attention deficits.

Training

Before data collection started, the subject was taught to use two templates during two 15- to 20-min training sessions conducted on 2 consecutive days with initial cuing for each pine board. She was instructed to trace the first template and then place the second template to the right of the first one with a space equal to the width of her index fingertip (see Figure 2). Once she traced the second template, she was cued to place the first template to the right of the second template for tracing the third bracket. She continued to use this alternating procedure until she reached the end of the pine board.

The results of the two training sessions were as follows: After the 15th trial, the subject required 2 verbal cues for each template; after the 21st trial, 1 verbal cue was required for each template. Typically, she needed reminders to leave a space between templates and to pick up the correct (i.e., left) template.

Data Collection

During the two baseline phases, the subject used one template to outline brackets. After she outlined the first bracket, she either flipped the template $360^\circ$ or simply slid the template along the pine board to outline another bracket. Because of her cortical blindness, she was not able to see the tracing line clearly, thus the space between the outlined brackets was either less than 1.3 cm or more than 2.6 cm, which did not meet the criteria to produce seven brackets (see Figure 3). She understood that it was important to leave a space between the tracing marks.

During the two intervention phases, the tracing technique was the same as that used in the training sessions. The subject outlined brackets by tracing a template in exactly the same way during both baseline and intervention phases. The only difference for the two phases was that the subject used one template during baseline and used two templates during intervention.

During the first baseline (Phase A1) and intervention phases (Phase B1), the subject was reminded to leave a space after she completed the first template on each board, thus six verbal cues were provided per session. During the second baseline (Phase A2) and intervention phases (Phase B2), she was only reminded to leave a space after she completed the first template of the first pine board, thus only one verbal cue was provided per session. The instruction was "Make sure you leave a space between each tracing." The duration to complete the whole activity (six pieces of pine board) in each session during the second phases of baseline and intervention was timed.

Measurement

The productivity score was the number of potentially usable outlined brackets produced in each session divided by 42, the maximum number of brackets that could be cut out. The principal investigator scored all the outlined brackets conducted in 29 sessions. There were 4 sessions in the first baseline phase, 9 in the second baseline phase, 9 in the first intervention phase and 7 in the second intervention phase. A second rater who was blind to the purpose of the study independently rescored the bracket.
Results

The mean productivity for each phase is shown in Table 2. Separate comparison of the results of the baseline and intervention phases shows that the subject’s accuracy improved with practice. The productivity increased from 60.1% to 65.1% when she used one template and from 87.0% to 95.6% with an additional template. Comparison of the baseline with the intervention phase shows that productivity improved 28.7% when an additional template was used (see Figure 4).

The C-statistic for the data B1 and A2 (18 data points) was .736; standard error was .223. The results ($Z = 3.30$, $p < .001$) indicated that a statistically significant change in trend occurred across the B1 and A2 phases.

The C-statistic for the A2 and B2 (16 data points) was .234; standard error was .804. The results ($Z = 3.44$, $p < .001$) indicated that a statistically significant change in trend occurred across the A2 and B2 phases.

The mean time to complete the six pine boards during the second baseline phase (A2) was 9.86 min. The mean time during the second intervention phase (B2) was 11.79 min.

Discussion

Purposeful use of objects in the area of skill learning applied to persons with physical dysfunction has not been systematically studied. This study demonstrates that productivity on a woodworking task of a woman with cortical blindness improved significantly when she used an additional template. The simple adaptation allowed the subject to complete an assigned routine woodworking task with increased accuracy.

The use of an additional template tapped into the subject’s intact tactile system to complete the task in a more productive manner. The results of her performance on this project proved that the subject was able to learn tasks via sensory systems other than her impaired visual system, which was consistent with the neuroophthalmologist’s recommendations.

This woodworking project was only part of the subject’s prevocational training. With her improved attention span on task and decrease in delusional expression, which may also be due to her improved compliance with medication (Yuen, 1992), the subject was placed in a paid job site at the animal barn at the rehabilitation center. This was the first time since her accident that the subject was capable of working in a supported employment situation. Placement was determined on the basis of the subject’s interest in working with animals and her performance on this project.

The subject’s increased productivity from A1 to A2 and from B1 to B2 suggests that the subject learned the procedure regardless of technique used to perform the task. However, the incremental increase was greater in the B-phase than in the A-phase. One of the merits of using ABAB design is the consideration of the learning factor when comparing the results of the A- and B-phases.

Due to the subject’s severe attention deficits at the time of the study, productivity across a longer duration was not possible. The limited amount of time the subject engaged in each session of the activity would not validate the results if speed were taken into account as the dependent variable. In this study, accuracy of task performance was more important for the subject than was speed of task performance. The amount of time taken was included to show that the subject was able to complete the task within the expected time given, which was 15 min. The mean difference in the amount of time used in A2 and B2 phases was less than 2 min, which seemed too small to warrant reinterpretation of the results.

However, Spooner and Spooner (1984) recommended that productivity should incorporate efficiency (i.e., how much time it takes a subject to complete the task) as well as effectiveness (i.e., the accuracy with which the task is completed). Future studies should measure the rate of correctness (correct frequency) and incorrectness as the primary dependent variables to meet the criteria of accuracy (effectiveness) and speed (efficiency).

It is imperative to consider the cost-benefit of the adaptation against productivity. In this study, the adapta-

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Table 2
Results of the Use of an Additional Template on the Subject’s Productivity

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<thead>
<tr>
<th>Measure</th>
<th>A1</th>
<th>B1</th>
<th>A2</th>
<th>B2</th>
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<tr>
<td>Productivity (%)</td>
<td>50.0-66.7</td>
<td>78.6-95.2</td>
<td>59.5-69.1</td>
<td>88.1-100.0</td>
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<tr>
<td>Time to complete (in min)</td>
<td>6.67-13.35</td>
<td>10.17-13.83</td>
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tion increased productivity without elaborate equipment designs and prolonged training. The occupational therapist should consider the complexity of the adaptation, amount and intensity of training required, and acceptance to both employer and trainee. For example, what is the cost-benefit of using an adaptation that improves the task performance of the persons with disabilities, but hinders other nondisabled workers using the same equipment or engaging in the same activity with the adaptation installed? In future studies, both productivity and safety may be examined as dependent variables.

The rationale for using an additional template to improve productivity can be explained by the theory of affordance proposed by Gibson (1966). Affordance is defined as an object that provides perceptual feedback on how to engage in an activity; for example, a graspable object, like a dowel, affords a grasping activity. Gibson (1982) proposed that an affordance is any object that can provide sensory information to a person engaged in an activity. Gibson (1977) emphasized that “the affordance of anything is a specific combination of its substance and its surfaces taken with reference to an individual” (p. 67). The affordances of an object therefore depend on the person and the characteristics of the object. Recent studies (Mark, 1987; Warren, 1984; Warren & Whang, 1987) confirmed that persons perceive the relationship between environmental properties and their action system to guide activity. Yuen (1988) demonstrated that the provision of additional objects (affordance) in prosthetic device training sessions facilitated motor skill learning. In the present study, affordance was created through the use of two templates with a space between them in which the subject could place her index fingertip. The haptic perceptual feedback to leave a space between templates resulted in increased accuracy of performance. Unlike previous studies on affordance, this study investigated affordance from the haptic perceptual perspective rather than from the optical perceptual perspective (see reviews by Michaels, 1988). This pilot study attempted to translate Gibson’s affordance theory into a testable hypothesis.

As Gibson (1966) postulated, affordance links perception to action. Occupational therapy links action to learning and skill performance. In this study, the subject increased her vocational potential, attention, and ability to learn through another sense. Through structuring the environment and adjusting the amount of affordance provided to a client, the occupational therapist can design activities to meet therapeutic needs and facilitate a person’s productivity or learning potential.
Acknowledgments

I thank Patricia Wilson, BA, David Nelson, PhD, OTR, and Joyce Hartwick, OTM, for their editorial assistance.

References


