Contributions of Behavior Modification to Cerebral Palsy Habilitation

LINDA D. HILL

The application of behavior modification techniques to cerebral palsy habilitation combines behaviorist psychology and physical therapy. In working together, physical therapists and behaviorists have a great deal to offer children and adults with cerebral palsy. I present a behaviorist perspective on how cerebral palsy affects an individual’s interactions with the environment and how the environment can be modified to teach and improve motor functioning. The usefulness of this perspective in guiding physical therapy is discussed and research in which behavior modification has been used in cerebral palsy habilitation is reviewed.

Key Words: Behavior therapy, Biofeedback (psychology), Cerebral palsy.

The application of behavior modification techniques to the physical habilitation of individuals with cerebral palsy (CP) is a promising area of behaviorist medicine that combines the expertise of behaviorist psychology with that of physical therapy. These two different disciplines have a great deal to offer each other, and, by working together, have a great deal to offer children and adults with CP. This article will present ways in which behaviorism has contributed to CP habilitation to encourage such a multidisciplinary approach. I will give, first, a behaviorist analysis of how CP affects an individual’s interactions with the environment and, second, a rationale for the use of applied behavior analysis to guide physical therapy treatment. Third, I will review research that has been done in this area.

BEHAVIORIST ANALYSIS OF CEREBRAL PALSY

The term, cerebral palsy, describes many kinds of neuromuscular dysfunction that have resulted from damage to the CNS before or shortly after birth. Given the wide range of differences among individuals with CP, making general statements is difficult, but some common patterns of environmental interaction and subsequent effects on motor and physical development can be identified. No matter what the degree and type of initial dysfunction, CP is a lifelong disability factor influencing interactions with the environment.

First, the motoric difficulties limit an individual’s mobility and, thus, opportunities to practice movements. Lack of mobility limits access to manipulable objects and other stimuli that can cue motor movements and limits the strength, frequency, timing, and accuracy of responses that are made. As a result, appropriate movements are infrequently performed and less frequently reinforced. Therefore, appropriate motor responses that are prerequisites for more complex motor skills may seldom or never have an opportunity to be developed or may undergo extinction. Individuals stop making responses that are never followed by positive consequences.

Second, for some individuals with CP, moving in certain ways is punishing because some movements elicit abnormal reflexes, painful muscle spasms, or both. Some movements become painful because tendons tighten and muscles atrophy through lack of use. When moving in certain ways is consistently punished, the individual will avoid making those movements as much as possible.

In addition to developing impoverished repertoires of motor behaviors, CP individuals may develop deviant patterns of responses in two ways. First, unwanted responses may result because of lack of control. Drooling and various forms of dyskinesia are two common kinds of deviant motor behaviors resulting from lack of control. Second, unusual patterns of movement may develop when abnormal sets of responses are reinforced instead of more usual patterns of movement. For example, when children with CP are learning to walk, they will often learn a method of locomotion that is effective in getting them from place to place but is a very different pattern of movement than that used by non-CP walkers. Some of these inappropriate patterns of behavior are very resistant to treatment. This resistance may be because these responses have been learned and maintained on intermittent schedules of reinforcement. In an intermittent schedule of reinforcement, a behavior is only reinforced occasionally, rather than every time it occurs. This type of schedule results in patterns of behavior that are extremely resistant to extinction. Intermittent reinforcement may also explain why some children with CP are so persistent in trying to learn motor skills that are very difficult for them. Because their actions are intermittently, rather than continuously, successful, individuals with CP tend to persevere at difficult tasks over many, many attempts.

The motor behavior of individuals with CP will depend not only on their interactions with the physical environment but also on their social interactions with other people. How others interact with children and adults who have CP has not been studied systematically, but interaction probably varies widely depending on factors such as the past experience of the interactors, the kinds of support and educational services available, and the extent and nature of the CP individual’s disabilities. In general, individuals with CP probably interact socially relatively infrequently. Those with CP require more physical care than nonhandicapped individuals for a larger proportion of the day and...
Rationale for Behavior Modification in Cerebral Palsy Habilitation

Although the handicap of CP cannot be cured, the environment can be modified in ways that will break the patterns I have described. The goals in any form of CP habilitation are to improve the individual's motor functioning and to prevent or decrease physical deterioration. The technology of behavior modification is completely compatible with these goals.

The general strategy of behavior modification is to apply principles of operant conditioning in teaching new behaviors and changing problem behaviors. The procedure basically involves four steps that are repeated again and again in the course of treatment.

1. The individual's current behavior is objectively assessed and quantified.
2. The environmental context is examined by analyzing the tasks to be accomplished and the contingencies in effect.
3. The behavioral targets are set.
4. A behavioral treatment is begun.

After a period of treatment, the four-step procedure is repeated. This process may be repeated after several days or weeks of intervention, or it may be repeated several times within a short session.

Mandel listed several advantages of the application of behavior modification in CP habilitation. First, the procedure actively involves the client and so should optimize physiological and motor learning. Second, this approach involves frequently repeating movements at a high rate of success. Third, and most importantly, in the behaviorist approach, immediate, objective and accurate feedback about performance is provided to both the client and the therapist.

Feedback guides therapists in administering consequences and helps shift some of the responsibility for motivation from the client to the therapist. If the client is not progressing on a behavior modification program, the therapist cannot rationalize failure by blaming the client for being unmotivated. Instead, the therapist has the responsibility to analyze the task to be accomplished, specify appropriate target behaviors, and use adequate reinforcers, so that the client can be on an appropriate schedule of reinforcement.

Feedback also makes it very easy to keep records, base decisions on objective data, and do clinical research. In this type of research, single-case methodology in which repeated measures are made of a single subject's behavior over time in response to one or more treatments is often used. It is no wonder that behavior analysts have been at the forefront in developing this type of single-case research methodology.

The four-step operant conditioning procedure and single-case research methodology have been found to be valuable tools in providing physical therapy services to individuals who have CP. To summarize the kinds of problems that have been addressed and treatment programs that have been developed, I will review the research in this area in the next section.

Research in Behavior Modification of Cerebral Palsy

Behavior modification techniques have a wide range of application in CP habilitation. A variety of motor skills have been taught or modified including head control; mouth, jaw, and throat movements; arm and hand movements; and correct sitting, walking, motor play, and relaxation. A number of these studies have used biofeedback instrumentation that can measure very small changes in behavior quite accurately.

Head Control

Sachs and Mayhall were among the first to modify head control behaviorally in an individual with CP. They used aversive conditioning, in which electric shock was administered, whenever their subject, a 20-year-old university student, lost eye contact for more than two seconds or had spasms. During eight sessions, head control increased and spasms declined from 70 responses a session to near 0.

Instead of punishment, most researchers have taken a more positive approach. Social reinforcement was used in teaching head control, eye contact, and vocalization to a severely retarded, institutionalized 9-year-old girl with CP. Verbal instructions, praise, corrective feedback, prompting, and fading were used in teaching three non-verbal CP adults to use a head pointer as a prerequisite to teaching them to use a communication board.

A number of studies have used head-position trainers to help teach head control to children with CP. These special helmets electronically measure angle of head tilt and provide feedback about head position. The usual training procedure uses a combination of positive and negative reinforcement. The children attempt to keep their heads straight for a longer period of their lives. Time spent giving physical care may take away from time that could be spent interacting with CP individuals in other ways, including the teaching of motor skills. The interactors may fail to teach CP children and adults certain motor skills because these interactors inadvertently tend to set their standards too high and so fail to reinforce any approximations the children and adults make. The limited mobility of children and adults with CP also reduces the number of interactions that the children and adults with CP are likely to initiate. Lastly, progress may be so slow or behavior patterns so unusual, that people in the CP individual's environment receive very little reinforcement for interacting and so initiate interactions less often.

The above discussion is a behaviorist perspective on why individuals with CP tend to learn motor skills such as manipulating objects, walking, eating, speaking, and writing slowly, if at all, and why they may learn unusual ways of accomplishing these and other tasks. From this perspective, the neuromuscular disability alone does not cause motor difficulties, but difficulties do result from the interaction of the disability with the environment. Cerebral palsy is not considered to be a degenerative disease, but poor motor development is often the result of such patterns of interaction. Physical deterioration can occur in individuals with CP, again not because of the disability on its own, but in the way this condition influences the interactions of the individual with the environment. Unused muscles atrophy, years of poor sitting and poor posture result in scoliosis and hip deformities, and spastic muscles lead to tightening tendons.

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to keep electronic equipment, such as tape recorders or movie projectors, turned on (positive reinforcement). When the children's heads deviate from a neutral position, the electronic equipment turns off and sometimes, the children hear an aversive noise, such as clicks or beeps. The children turn the aversive stimulation off when they move their heads back into a straight, neutral position (negative reinforcement). This also turns back on the positively reinforcing stimulation.16-22

Wolpert and Wooldridge helped a 14-year-old girl with mild CP improve her head position by providing EMG biofeedback about the activity in her sternocleidomastoid muscles.23 The subject was conditioned to avoid making one tone (indicating left muscle activity) and to make a different tone (indicating right muscle activity). Although biofeedback training was successful and head position improved during 11 sessions, the subject showed no generalization to other situations. The researchers suggest that using and gradually fading a portable EMG device might have helped the subject generalize and maintain appropriate head position.

Mouth, Jaw, and Throat

One of the most socially unacceptable difficulties that many individuals with CP have is drooling. Garber administered praise and pennies contingent on not drooling during a designated time period to a 14-year-old boy.24 The length of the time periods was gradually increased as drooling decreased. Barton et al taught two institutionalized young men to swallow and decrease drooling using shaping procedures in which approximations of swallowing behavior were reinforced with candy and tokens, and drooling was punished with an aversive auditory consequence.25 This modification procedure was lengthy, but the authors contended that decreasing this undesirable behavior, at least partially, contributed to more positive social interactions with staff and more access to activities for cumulative performance. Rapp and Bowers reported positive results from a project to teach drooling control.26, 27 When Jones attempted to replicate that study, however, he found that the baseline data were too short and too variable for any valid conclusions to be drawn.4

Behavioral methods have also been used to improve eating behaviors. Kol-derie described a case study in which food, tokens, social reinforcement, and graphs of progress were used to reinforce correct eating behavior and pronunciation of sounds in a 10-year-old girl with CP.28 Thompson et al decreased tongue thrusting and improved eating behavior in a young child with spastic CP.29 During mealtime, the child was reinforced with food when his tongue was inside his mouth. When the child's tongue was out, the staff pushed it back in with a spoon and gave no food. Paraprofessional staff were easily trained to follow this treatment procedure.

Arm and Hand Movements

Harris et al used an electronicgoniometer to monitor arm position in CP children.16 Feedback was provided on a large dial, which children attempted to move within preset limits to avoid activating a buzzer. All children using this monitor showed an increase in range of motion, and smoothness and accuracy of moving their arms.

Ball et al also used an automated goniometer to monitor arm movements in one subject and leg movements in another.30 Musical feedback was contingent on correct extension and flexion movements. The procedures were effective for one subject but not for the other.

In two studies, a series of lights provided reinforcing feedback to the subjects for successfully doing a digital exercise of sequentially touching the fingers to the thumb. One subject's speed improved over time partly from practice but partly from the provision of feedback.31, 32 A second subject showed improved performance on the task and a decrease in overflow movements of the shoulder, head, and tongue.33

Brudny et al selected EMG biofeedback to train a young woman to use her left hand. She eventually became able to use this hand for activities such as eating and cooking.34 Verbal praise and food as a reward were effective in training three children to propel their wheelchairs with their hands.35 Asato and associates used EMG biofeedback to monitor muscle activity and activate music contingent on wrist and finger extension by a mentally retarded woman with CP.36 The client gained some functional use of her left hand and became able to clap, hold hands, and hit her thigh during dance therapy.

Two groups of researchers have taught the skill of pointing, to severely retarded individuals with CP.37 In both cases, this skill was a prerequisite for participating in more complex communicative and conceptual development programs; teaching a simple motor response may sometimes be the initial "break-through" in helping a CP individual develop a wide repertoire of functionally useful behaviors.

Sitting

Bragg et al compared the effects of prompting and then providing positive social reinforcement for correct sitting with providing positive social reinforcement alone for correct sitting in six young children with CP.38 The children who received both prompting and reinforcement learned faster than those who received reinforcement alone, but all children improved and four of the six children generalized correct sitting behavior from the treatment setting to the classroom setting.

Walking and Leg Movements

In an early study, Meyerson et al observed that the adults in a young boy's environment seemed to be reinforcing nonwalking behavior with attention.39 The researchers changed this environmental influence by reinforcing successive approximations of walking and safe falling behaviors with attention and praise.

Weight bearing was taught to another young boy by providing feedback from a scale.39 When more than 39 lb (18 kg) was indicated on the scale, the therapist immediately reinforced the child by letting him make a move in a racing game and by social praise. He also earned toys and activities for cumulative performance. The researchers noted that reinforcers had to be changed often to maintain the child's motivation.

Switches were attached to the toe of the left shoe of a male university student with CP who dragged his foot while walking.40 He was punished with the sound of a bicycle horn whenever his foot dragged. Foot dragging was reduced to near zero even when the feedback from the bicycle horn was gradually faded. During follow-up three months later, however, the student did not maintain the improvement measured in earlier training sessions.
A joint position trainer (an electromyograph and auditory feedback unit) provided feedback about the gaits of two young children in a study by Woolridge et al.41 Stickers were used to reinforce improvements over sessions. Both children showed improvement with training but did not maintain their improved gaits without the feedback equipment.

Electromyographic biofeedback helped a subject increase active range of motion in each ankle joint and decrease the time needed to relax after muscle contractions.42 This improvement was maintained in both ankles during follow-up four and nine weeks later. The authors suggested that this subject maintained the improvement because he was able to transfer skills learned during treatment sessions to daily living activities.42

Relaxation

Relaxation of spastic muscles is considered a prerequisite for learning motor control.43 Researchers have used EMG biofeedback successfully to train relaxation and, consequently, have improved motor skills in children and adults with CP.43-45 Other relaxation training techniques, including progressive relaxation training,46 and systematic desensitization,47 have also been found to be successful.

CONCLUSION

The studies I have reviewed demonstrate that the combination of behavior modification and physical therapy is an effective way of treating clients who have CP. Each study followed the same basic procedure of 1) objectively examining a behavior in its environmental context, 2) setting a target behavior, 3) developing a treatment program in which environmental contingencies were systematically and consistently manipulated to achieve that target behavior, and 4) measuring the effectiveness of the program.

Although this procedure may seem simple, the appropriate application of behavior modification technology in physical therapy requires a sound background in behaviorism. The treatment programs I have reviewed showed a wide variation in what was measured, how the contingencies were manipulated, and size of the treatment steps performed.

Teaching a course in behavior modification is beyond the scope of this article. Instead, by summarizing studies that have demonstrated what can be accomplished, I hope that physical therapists will be encouraged to work with behaviorists in developing and monitoring treatment programs. Through this type of hands-on, practical teamwork, the expertise from these two disciplines can be effectively combined to help individuals with CP improve their motor functioning and to measure the progress that they make.

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