Abstract: This study investigated the use of adapted bicycles on the acquisition, maintenance, and generalization of conventional cycling by seven children with mild mental retardation. Feedback was used in addition to the adapted bicycles and consisted of pedal rate, head position, and steering participation. A multiple probe design was used. Participants were required to ride as far as possible for each trial. Results indicated that 100% of participants demonstrated acquisition of conventional cycling. Maintenance was demonstrated by 71.4% of participants, and generalization was demonstrated by 42.9% of participants. Results are interpreted from an ecological perspective.

Considerable attention has been given over at least the past two decades on the learning of motor skills by individuals with mental retardation (MR) (Bouffard, 1990; Hoover & Wade, 1985). It is generally known that individuals with MR can typically acquire simple motor skills (e.g., Gillespie, 2002, 2003; Yang & Porretta, 1999). However, these same individuals have difficulty learning complex skills (Porretta, 1990; Reid, 1993). In motor performance tests of eye/hand coordination, balance, and body coordination, Eichstaedt, Wang, Polacek, & Dohrmann, (1991) found that children with mild or moderate MR scored significantly lower than children without MR. Due to deficits in balance and coordination, children with MR experience difficulty in learning and performing motor tasks, especially when task complexity increases (Wade, Newell, & Wallace, 1978) and the task requires a temporal response (Kail, 1992; Newell, Wade, & Kelly, 1979).

Historically motor learning research on persons with MR lacked the use of ecologically appropriate tasks (Reid, 1993). However, more recently, research on the learning of motor skills has focused on tasks that have direct relevance to daily life (Davis & Burton, 1991; Sherrill, 2004). Bicycling is such a task. It allows individuals the opportunity for independent travel or travel with family or friends. However, many individuals, especially those with disabilities, have never learned to ride a conventional bicycle (Joules, 1996). This is especially true for persons with mental retardation (MR). It is difficult to pinpoint why there is such a low number of cycling participants compared to other sports opportunities. It could be attributed to the lack of equipment, finances, or programming. Special Olympics International offers bicycling as a competitive event, however few athletes participate. Statistics from Ohio Special Olympics indicate that only 313 individuals with MR compete in cycling events compared to 7,469 competitors in track & field events and 8,448 competitors in bowling events (M.S. Allen, personal communication, December, 2005). These figures can be considered representative of participants in other states. However, perhaps a greater number of individuals with
MR might actively participate in cycling programs if learning to ride were not such a complicated motor task. Riding a conventional bicycle requires appropriate levels of eye-hand coordination, balance, and response time.

A variety of training aids and devices have been developed and patented over the years in an attempt to simplify the learning of cycling (e.g., Egley, 1994; Harrison, 1995; Henrichs, 1996; Kalmus, 1994; Rieber, 1992). However, the use of training wheels (Egley, 1994; Rieber, 1992) is probably the most popular method for introducing cycling skills to young children. Training wheels keep the novice rider in an upright position, however, they are actually counterproductive in learning how to balance and ride a conventional bicycle. The use of training wheels elicits inappropriate feedback responses. When using training wheels, the tendency is to lean to one side or the other as the bike moves forward on three wheels (typically two cycle wheels and one training wheel). This in turn, results in a preoccupation with the upper torso as a balancing mechanism. This tendency is noticeable as upper-body articulation (shifting of shoulders to one side or the other) is pronounced when observing a child attempting to balance a two-wheel bicycle after many years on training wheels.

In terms of achieving balance on a conventional bicycle without training wheels, the appropriate technique requires one to steer in the direction of the fall or lean. Roberts (1995) explains that the path of a bicycle is not a straight line, but one of constant lateral oscillations. The reason for these oscillations is that any tendency to fall to one side or the other is promptly arrested by a corresponding horizontal movement in the same direction. With this in mind, balancing a bicycle is much easier and more productive when the arms are loose and participate in the steering process. Again, the use of training wheels may tend to inhibit this necessary action. The arms are often observed as being rigid and inflexible as a result of a preoccupation with the upper body as an alternate balancing mechanism.

To our knowledge, no empirical research has been completed that has addressed the learning of conventional bicycling skills for individuals with MR. Therefore, the purpose of this paper is for children with MR to use a series of adapted bicycles in order to acquire, maintain and generalize the skill of riding a conventional bicycle. During the acquisition phase, we had participants use a series of adapted bicycles and provided participants with feedback relative to head position, pedal rate and steering participation. According to Bouffard (1990) appropriate feedback is an essential element in learning motor skills for individuals with MR.

This study adopts an ecological perspective (Davis & Burton, 1991) relative to the learning of conventional bicycling. The interaction of all elements in the environment is taken into consideration upon learning a new skill. More specifically, the perception-action approach introduced by Gibson (1976) uses the term affordance to describe the function that an environmental object might provide a particular individual. For example, a conventional two-wheel bicycle might be the appropriate learning tool for a child without disability. However, for a child with body coordination and balancing difficulties, a modified bicycle may be more appropriate during the initial stages of learning. Achievement of movement goals are related to the characteristics of the individual as well as to environmental objects, which afford certain movements to that individual (Haywood & Getchell, 2001). The use of a series of adapted bicycles would represent a progressive change in the task at hand, in that forward speed and tipping rate are tempered to allow children the opportunity to experience the dynamics of cycling in more forgiving and appropriate conditions.

Method

Participants

Participants for this study were purposefully selected based upon age, disability and the inability to ride a conventional bicycle. Seven elementary school students (6 males and 1 female) with mild MR (ages 7-11, M age = 9.3) participated in this study. These participants are those who would qualify for intermittent support services (Luckasson et al., 2002). All participants were receiving public school special education services in a Midwest-
ern state and were identified by the school district as mildly mentally retarded. In accordance with the definition of MR, all participants exhibited deficits in adaptive behaviors and significantly subaverage intellectual functioning (68 to 84 IQ scores). Participants had no known physical or sensory impairments that would inhibit performance of cycling skills. None of the participants were able to independently ride a conventional bicycle at the beginning of the study. Written informed consent was obtained from parents/guardians of each participant, prior to data collection. In addition, participants provided verbal assent to participate. Approval of research protocol was obtained from the author’s Institutional Review Board.

Bicycles

In this study, adapted bicycles as designed by the third author, an emeritus professor of engineering at the University of Illinois are used (Klein, McHugh, Harrington, Davis, & Lieberman 2005). Additional information about the adapted bicycles can be obtained on Dr. Klein’s website (www.losethetrainingwheels.org). Each adapted bicycle is described below:

Bicycle A. The “double roller” bicycle features two rollers in lieu of conventional pneumatic tires. The rollers have been mounted onto a 16 in or 20 in (40.64 cm. or 50.8 cm. tire diameter), single-speed bicycle frame. One roller is located in the front position and the other is located in the rear position of the bicycle. Both rollers to be used on bike A have crowns of 36.25 arc-inches (92.08 arc-cm.) (roller #5). The drive train is modified to convert the design to that of fixed gear as opposed to free wheel or “coaster brake” system.

Bicycle B. The rear roller bicycle is a variation on the two-roller bicycle above (see Figure 1). It features only one roller in the rear position; this roller has a crown of 36.25 arc-inches (92.08 arc-cm.) (roller #5). The front fork is configured with a conventional front fork and front tire. The drive train is a fixed gear system.

Bicycle C. The second rear roller bicycle is a variation on Bicycle B, in that the sprocket in the front is larger and the sprocket in the rear
position is smaller, allowing the bicycle to move forward at a quicker pace relative to pedal cadence. In addition, the rear roller used on Bicycle C has a crown of 26.35 arc-inches (66.93 arc-cm.) (roller #7).

**Bicycle D.** The “fat tire” bicycle is a standard 16 in or 20 in (40.64 cm or 50.8 cm) size frame, which features a wide, 16 x 8 x 5 in (40.64 x 20.32 x 12.7 cm) inflatable garden tractor style tire located in the front position. The rear tire is a conventional bicycle tire, with a conventional drive train.

The conventional bicycle used in this study is a single speed, 16 in or 20 in (40.64 cm or 50.8 cm) bicycle with pneumatic tires and coaster brakes. This is a child’s size bicycle and will appropriately accommodate children in the 7 to 11 age range.

**Design**

A multiple probe design (Cooper, Heron, & Heward, 1987) was used for this study. The multiple probe design is appropriate for evaluating the relationship between the independent variable and the acquisition of successive approximations of a skill. Rather than collecting prolonged baseline data on skills that were not yet developed, intermittent measurements provided the information necessary to determine whether or not a change had occurred prior to intervention. All participants were introduced to conventional cycling through a series of four progressively challenging adapted bicycles. Social validity was obtained by a questionnaire designed to acquire parents'/guardians’ opinions relative to their perceptions of learning conventional cycling via a progressive approach to cycling. The social validity questionnaire consisted of 10 questions with a four-item rating scale: strongly agree, agree, disagree, and strongly disagree.

Participants received individualized instruction three times a week, 45 minutes per session. Initial probes, baseline, acquisition, generalization, and maintenance took place inside a gymnasium. Participants were instructed not to practice cycling skills outside of study sessions. Parents/guardians were seated outside the gymnasium during all practice sessions. The researcher, two video-camera operators, and one participant, were present in the gymnasium at the time of data collection. This arrangement permitted participants to learn in an environment relatively free from distractions.

Each trial began at the “ready” line near the wall at one end of the gymnasium. The participant was instructed to mount the bicycle, position hands on handlebars, and feet on pedals. The instructor pushed the bicycle forward 1.5 m to the starting line. As the front tire of the bicycle touched the starting line, the lead researcher released her hand from the bicycle’s seat. This is the point where measurement of each trial began. The trial ended when: (a) the investigator touched the participant or the bicycle, (to intervene prior to a fall) (b) the participant touched the floor, or (c) the front tire of the bicycle touched a side boundary line. Upon completion of each trial, the child was instructed to dismount the bicycle and walk back to the starting position. Participants did not advance to the next bicycle in the series until a criterion level of performance was attained on the current bicycle. Criterion was set at 12 m of independent riding on 3 out of 5 consecutive trials.

**Initial Probes.** At the first training session, the participant’s helmet was appropriately adjusted for his/her head size. Once the helmet was in place, all five bicycles were adjusted to fit the participant so that both feet could easily touch the ground flat-footed while seated. Once helmet and bicycle fitting were complete, the participant attempted one trial on each of five bicycles in the series. All five probes were completed without feedback. The initial probes served to establish a starting point relative to the relationship between the independent and dependent variables of interest.

**Baseline.** Following initial probes, a baseline was established for the first bicycle in the series (Bike A). The baseline trials were performed without feedback. Each participant was told to ride the bicycle as far as he/she could. Once a steady state of responding was established for a particular bicycle under baseline conditions, the instructor began providing feedback following each trial. The purpose of requiring a stable pattern of response was to eliminate extraneous influences on performance, thereby providing an accurate picture of the full efforts of that condition prior to the introduction of another variable. The
number of trials under baseline conditions differed from participant to participant and from bicycle to bicycle.

**Acquisition.** Once a baseline was established for a particular bicycle, the acquisition phase began. At the completion of each trial, the instructor provided positive, positive/corrective, or positive/specific feedback. Feedback addressed pedal rate, steering participation, or head position. During the acquisition phase, participants rode the bicycles in sequential order (1) Bicycle A, (2) Bicycle B, (3) Bicycle C, (4) Bicycle D, and (5) Bicycle E (conventional bicycle). Participants did not advance to the next bicycle in the series until a criterion level of performance was attained on the current bicycle. Criterion was set at 12 m of independent riding on 3 out of 5 consecutive trials. Once criterion level performance was attained on a particular bicycle, one generalization probe was taken on that bicycle. Response generalization required the participant to perform a variation of the task. In this case, the participant was required to navigate through a series of cones. Following this, a single trial (probe) of each bicycle remaining in the series was taken to determine whether performance changes had occurred in any other steps. Once all probes were completed, the next bicycle in the series would be introduced in a similar manner.

**Maintenance.** Maintenance is defined as the extent to which a learner continues to perform a target behavior upon completion of the intervention (Cooper et al., 1987). In this study, a maintenance session was conducted 2-3 days following acquisition of cycling skills on the conventional bicycle (Bike E). During the maintenance session, the participant was asked to complete a maximum of 15 trials. Maintenance trials were not accompanied by feedback. Following maintenance trials, during the same session, generalization trials were completed.

**Generalization.** The generalization session took place 2 to 3 days following acquisition of cycling skills on the conventional bicycle. During generalization trials, response generalization was targeted to elicit the participant’s ability to perform a variation of the cycling task. The cones were set up in a weaving pattern and the participant was requested to complete a maximum of 15 generalization trials navigating through the cone arrangement.

**Procedure**

Interobserver agreement data were collected by two independent observers through videotaped sessions. Treatment integrity was ascertained through onsite observations to ensure that the independent variable was presented in an accurate and consistent manner. Social validity data were obtained from parents who provided opinions relative to the efficacy of utilizing adapted bicycles as a learning tool and the importance of cycling skills for recreation and leisure.

Visual inspection of graphs was used to interpret data. Individual graphics were utilized for the distance traveled independently across five bicycles (Bicycles A-E). Data analysis consisted of both within-phase and between-phase analysis. Visual analysis involved a determination of the number and variability of data points, in addition to the level of performance and the direction and degree of trends. Social validity data were analyzed using percentage of responses for each question.

**Results**

**Interobserver Agreement**

Interobserver agreement data for bicycling acquisition were collected across all seven participants. Session-by-session interobserver agreement data of distance by trial were taken from seven sessions across all five bicycles (Bicycles A-E). Sessions were selected based upon a predetermined schedule. The mean interobserver agreement for cycling distance by trial was 97.1% across seven participants (range 92% to 100%).

**Procedural Integrity**

Procedural integrity was established by the use of a procedural reliability checklist consisting of seven questions. The video-camera operator completed the procedural reliability checklist at the end of each session. Across all sessions for all participants, procedural reliability was calculated at 99% (range 97 to 100%).
Performance of Participants across Five Bicycles

Participant 1 (male) participated in one session for acquisition. Total trials were 29 for acquisition of conventional cycling skills (see Figure 2). The acquisition phase encompassed initial probes, baseline, and training trials. Initial probes on Bicycles A-E were 12, 4, 1, 12, and 3 m respectively. Participant 1 immediately reached criterion levels on Bicycles A-E during baseline. Participant 1 demonstrated maintenance consistently, cycling a distance of 12 m, during 100% of the maintenance trials. Participant 1 demonstrated generalization intermittently, cycling through ob-

![Figure 2. Participant #1 performance across bikes A-E.](image-url)
stacles a distance of 12 m, during 50% of the generalization trials.

Participant 2 (male) participated in two sessions for acquisition. Total trials were 50 for acquisition of conventional cycling skills (see Figure 3). Initial probes on Bicycles A-E were 12, 0, 9, 1, and 3 m respectively. Participant 2 immediately reached criterion levels on Bicycles A-C during baseline conditions. Baseline for Bike D consisted of 6 trials with an average distance of 2.5 m. The data path for training trials on Bike D was extremely variable, ranging from 0-12 m. After 11 trials with feedback, participant 2 successfully reached criterion
level on Bike D. Baseline for Bike E consisted of 5 trials with an average distance of 11 m. After 5 trials with feedback, participant 2 successfully reached criterion levels on Bike E. Participant 2 did not demonstrate maintenance, although he did cycle a distance of 12 m on 3 separate trials (20%). Participant 2 demonstrated generalization consistently at criterion level (80%).

Participant 3 (male) participated in four sessions for acquisition. Total trials were 156 for acquisition of conventional cycling skills (see Figure 4). Initial probes for Bicycles A-E were 12, 0, 0, 0, and 0 m respectively. Partici-
Participant 3 immediately reached criterion level on Bike A during baseline conditions. Participant 3 met criterion levels during baseline conditions on Bikes B and C within 6 trials. Baseline for Bike D consisted of 3 trials at 1, 1, and 0 m respectively. Participant 3 demonstrated a variable data path (range of 0-7 m) throughout the first 74 training trials (two-thirds of all training trials) on Bike D. For the remaining 27 training trials, the data path became extremely variable, (range of 2-12 m). During this period, Participant 3 met criterion levels on Bike D. Baseline for Bike E consisted of 3 trials with an average distance of 4.6 m. After 12 trials with feedback, participant 3 successfully reached criterion levels on Bike E. Participant 3 demonstrated maintenance consistently, cycling a distance of 12 m during consecutive trials (90%). Participant 3 demonstrated generalization intermittently, cycling through obstacles a distance of 12 m, during 40% of the generalization trials.

Participant 4 (male) participated in six sessions for acquisition. Total trials were 227 for acquisition of conventional cycling skills (see Figure 5). Initial probes for Bicycles A-E were 12, 1, 1, 0, 0 m respectively. Participant 4 immediately reached criterion level on Bike A during baseline conditions. Baseline for Bike B consisted of 4 trials at 0, 3, 0, and 1 m respectively. Participant 4 demonstrated maintenance consistently, cycling a distance of 12 m during consecutive trials (90%). Participant 4 demonstrated generalization intermittently, cycling through obstacles a distance of 12 m, during 40% of the generalization trials.

Participant 4 immediately reached criterion level on Bike A during baseline conditions. Participant 4 did not demonstrate generalization, although he did navigate a distance of 12 m on 2 separate trials (13.3%).

Participant 5 (male) participated in seven sessions for acquisition. Total trials were 222 for acquisition of conventional cycling skills (see Figure 6). Initial probes for Bicycles A-E were 4, 1, 0, 1, and 1 respectively. Participant 5 met criterion level on Bike A during baseline conditions after 4 trials. Baseline for Bike B consisted of 3 trials; each at a distance of 0 m. Participant 5 demonstrated a steady data path (range of 0-1 m) for the next 19 trials on Bike B. It was evident, that Participant 5 was not making adequate progress on Bike B. At this point, a roller change was made. A less contoured roller replaced the original roller for Bike B. Participant 5 reached criterion level with the less contoured roller in place after 63 trials. Baseline for Bike C consisted of 3 trials at 4, 6, and 3 m respectively. Participant 5 met criterion level on Bike C after 8 trials. The data path during training on Bike C was extremely variable (range of 2-12 m). Baseline for Bike D consisted of 3 trials at 0, 1, and 0 m respectively. Baseline for Bike E consisted of 3 trials at 0, 1, and 0 m respectively. Participant 5 demonstrated maintenance, cycling a distance of 12 m during 45% of the maintenance trials. Participant 5 did not demonstrate generalization, although he did navigate a distance of 8 m on one attempt.

Participant 6 (female) participated in seven sessions for acquisition. Total trials were 389 for acquisition of conventional cycling skills (see Figure 7). Initial probes for Bicycles A-E were 12, 0, 3, 0, and 0 respectively. Participant 6 met criterion level on Bikes A-C immediately during baseline conditions. Baseline on Bike
D consisted of 3 trials; each at 0 m. During the first 165 trials of intervention, the data path was variable (range of 0-4 m). During the remaining 108 training trials, the data path became increasingly variable (range 0-12). Participant 6 met criterion level on Bike D after a total of 273 trials. Baseline for Bike E consisted of 5 trials of 4, 6, 12, 4, and 5 m respectively. Participant 6 met criterion level after 32 trials of intervention, demonstrating an extremely variable data path (range of 3-12 m). Participant 6 did not demonstrate maintenance, although she did cycle a distance of 12 m during one attempt. Participant 6 did

Figure 5. Participant #4 performance across bikes A-E.
not demonstrate generalization. Her best attempt at navigating through obstacles was 4 m.

Participant 7 (male) participated in seven sessions for acquisition. Total trials were 232 for acquisition of conventional cycling skills (see Figure 8). Initial probes for Bicycles A-E were 12, 1, 3, 0, and 1 respectively. Participant 7 immediately met criterion level on Bike A during baseline conditions. Baseline measures on Bike B consisted of 8 trials with an average distance of approximately 2 m. Participant 7 met criterion level on Bike B after 40 trials of intervention. During acquisition, the data path was extremely variable and gradually increasing on Bike B. Baseline measures on Bike C consisted of 5 trials with an average distance...
of approximately 5 m. Participant 7 met criterion level on Bike C after 28 trials of intervention. During acquisition, the data path was extremely variable on Bike C. Baseline measures on Bike D consisted of 3 trials at 3, 2, 3 m respectively. Participant 7 met criterion level on Bike D after 63 trials of intervention. During acquisition on Bike D, the data path was initially variable (range of 2-5 m), this was followed by an extremely variable data path (range 2-12 m). Baseline data on Bike E consisted of 7 trials with an average distance of approximately 8 m. Participant 7 met criterion level on Bike E after 38 trials of intervention.
During acquisition on Bike E, the data path was extremely variable (range of 2-12 m). Participant 7 demonstrated maintenance, cycling a distance of 12 m during 47% of the maintenance trials. Participant 7 did not demonstrate generalization, although he did navigate a distance of 4 m on several attempts.

Summary of Performance across Five Bicycles for all Seven Participants

The average number of trials to criterion level for each of the five bicycles was: Bike A, $M = 4.4$ trials (range 4 to 6); Bike B, $M = 40$ trials (range 5 to 106); Bike C, $M = 12.4$ trials.
Bike D, \( M = 92.9 \) trials (range 7 to 280); Bike E, \( M = 35.3 \) trials (range 7 to 94). The average number of total trials to acquisition of conventional cycling skill was 185 trials (range 29 to 389). In a comparison by gender, the average number of total trials to acquisition of conventional cycling skill was \( M = 151 \) trials (male) and \( M = 389 \) trials (female). On average it required 4.9 sessions to acquire conventional cycling skills. Gender comparison of total number of sessions reveals \( M = 4.5 \) sessions (males), and \( M = 7 \) sessions (female). Five out of seven participants (71.4%) were able to demonstrate maintenance of conventional cycling skill 2-3 days following acquisition. Three out of seven participants (42.9%) were able to demonstrate generalization of conventional cycling skill 2-3 days following acquisition. The only female in this study did not demonstrate maintenance or generalization of conventional cycling skill.

**Discussion**

The purpose of this study was to investigate the effects of the use of adapted bicycles on the acquisition, maintenance, and generalization of conventional cycling by children with mild MR. Acquisition of conventional cycling skills was achieved by all seven participants (100%) supporting the notion that individuals with MR can acquire motor skills (Gillespie, 2002; Porretta & Surburg, 1995; Yang & Porretta, 1999). Moreover, performance by athletes in Special Olympics events such as gymnastics, cycling, and swimming provides evidence that individuals with MR can become highly proficient at a variety of sports skills (Sherrill, 2004). Results also support the notion proposed by several investigators (Belmont & Mitchell, 1987; Bouffard, 1990; Wall, 1990) that skill progressions should be used. For example, the presentation of a series of adapted bicycles, representing a gradual continuum of change allowed the participants in this study to successfully progress toward the goal of riding a two-wheeled, conventional bicycle. In contrast, an instructional program that does not make appropriate equipment modifications to accommodate for the needs of a child with MR may not be as successful in terms of success rate and length of training. One example of such a program has been underway in Michigan (see www.bikeprogram.org). The director, John Waterman indicated (personal communication, June, 2004) that the Michigan D.O.T. sponsored program requires approximately sixteen weeks of training sessions and yet achieves lower success rates, typically fifty percent, as compared with the adapted bicycle based program used in this study. Follow-up empirical research is needed to verify this observation. Certainly, the interaction of the learner, the task, and the environment should be taken into consideration upon learning a new skill. An ecological perspective as used in this study (Davis & Burton, 1991) is important when teaching children with disabilities, especially those with MR.

Maintenance of conventional cycling skills was demonstrated by five out of seven participants (71.4%) following acquisition. Although this level of maintenance was fairly high, considering the difficulty that many individuals with MR have in maintaining motor skills, there is certainly room for improvement. In this study, the acquisition phase was terminated as soon as a participant met the criterion of three out of five consecutive trials at a distance of 12 m. This cut-off did not provide sufficient practice time riding the conventional bicycle. It has been recommended that to improve maintenance of motor skills, ample practice time should be provided (Bouffard, 1990; Porretta & O’Brien, 1991; Ulrich, Ulrich, & Angulo-Kinzler, 1998).

The generalization of conventional cycling skills was demonstrated by three out of seven participants (42.9%) following acquisition. Response generalization was utilized, in that participants were required to navigate through a series of cones while riding a conventional bicycle. The setting remained the same (inside a gymnasium) but the task was altered. There may be several reasons for the results. Perhaps the placement of the cones was too challenging after just learning to ride a bicycle from one end of the gym to the other. In this case, the task did not appropriately match the current ability of the learner. This observation supports Singer’s (1986) notion that positive transfer (generalization) effects will occur when the related task involves minimal change. Another reason may be related to practice time. Participants received minimal practice riding the conventional bi-
cycle. Therefore they did not have the opportunity to develop navigational skills.

There was a noticeable difference between male and female participants relative to acquisition, maintenance, and generalization. Overall, males acquired conventional cycling skills much faster in comparison to the one female participant in the study. On average, males acquired the skill in less than half the total trials, $M = 151$ trials (male) and $M = 389$ trials (female). This trend was also evident when examining total number of sessions, $M = 4.5$ sessions (males), and $M = 7$ sessions (female). Moreover, the female participant was the only participant in this study not to demonstrate either maintenance or generalization of conventional cycling skills. One possible explanation for the results relative to gender comparison would be that past experiences and personal attributes of the female participant may have differed considerably from her male counterparts. Potential characteristics that may have had a detrimental effect would be lack of opportunity, decreased muscular strength, lack of motivation, or negative experiences leading to increased levels of anxiety and fear. The female participant in this study was an only child. Perhaps she would have been more motivated or had more opportunities if she were exposed to siblings riding bicycles. However, anecdotal evidence appears to contradict the present findings relative to gender differences. The third author, in supervising approximately 1,000 children with disabilities (many with varying degrees of MR) in his adapted cycling programs for the period of 2001-2005, has not observed any significant gender differences as related to the ability to master bicycling skills.

In conclusion, the results of this experimental study demonstrate that the use of a series of adapted bicycles can lead to acquisition of conventional cycling skills for children with mild MR. It is suggested that future research in this area emphasize additional practice trials to increase both maintenance and generalization of conventional cycling skills. This would necessitate raising criterion levels. In addition, generalization to more applied settings such as outdoors or perhaps on a bicycle trail would be beneficial. Also, it is imperative to match the ability of the child to the task at hand. Not only does this practice lead to successful experiences, but it can also have a positive effect on movement confidence (Griffin & Keogh, 1982) and motivation (Harter, 1978). Finally, the use of specially designed bicycles as described and as used in a progression affords children with MR increased opportunities to succeed in the challenging task of riding a two-wheeled bicycle without training wheels.

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