

# Early Motor Intervention The Need for New Treatment Paradigms

***Gerald Mahoney, PhD; Cordelia Robinson, PhD, RN;  
Frida Perales, MEd***

Results from a recent study indicated that neither of the 2 treatment models that are commonly used with young children with motor impairment was effective in enhancing children's rate of motor development or quality of movement, at least over a 1-year time period. These findings add to an increasing body of literature indicating that contemporary motor intervention procedures are not adequately meeting the hopes and vision for motor intervention. These findings also serve as a call for the field to explore alternative treatment methods for providing services. In particular, there is a need for greater involvement of parents in intervention. There is also a need for a renewed research agenda that explores issues related to the intensity of services and dynamic motor theory. Funding models need to be modified to encourage recommended and innovative motor intervention practices. **Key words:** *cerebral palsy, Down syndrome, motor intervention, physical therapy*

**T**HE purpose of this article is to describe and discuss the results of a recent study that examined the effectiveness of 2 motor intervention approaches, Neurodevelopmental Treatment (NDT) and Developmental Skills (Dev Skills), with young children with Down syndrome and cerebral palsy (Mahoney, Robinson, & Fewell, 2001). We consider these findings in the context of current issues regarding the delivery of early motor intervention services. Specifically, we will consider the following: (1) the degree to which contemporary methods are achieving the goals envisioned for early motor intervention; (2) efforts to involve parents in the intervention process; (3) the need to investigate the effects of different degrees of intervention and focused practice on motor development outcomes; and (4) how funding poli-

cies may work against mandates such as natural environments, transdisciplinary models, instruction of parents, and use of assistive technology. Our discussion and recommendations are informed not only by this study, but also by our 25 years of experience in developing, implementing, and evaluating early intervention programs for children with varied diagnoses, including autism, Down syndrome, cerebral palsy, and developmental delays with unknown etiology.

## **INTERVENTION FOCUSED ON MOTOR SKILLS**

The NDT and Dev Skills approaches are 2 intervention models that are commonly used in professional practice. NDT was developed in England for treatment of children with cerebral palsy as well as adults who experienced stroke (Bobath & Bobath, 1964, 1984). NDT involves handling children to inhibit abnormal tone and facilitate automatic reactions, such as righting and equilibrium, to promote normal movement patterns (Bly, 1983, 1991). It attempts to mitigate the underlying impairments in the central

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*From the Case Western Reserve University, Cleveland, Ohio (Dr Mahoney and Ms Perales); and the University of Colorado Health Sciences Center, Denver, Colo (Dr Robinson).*

*Corresponding author: Gerald Mahoney, PhD, Case Western Reserve University, 10900 Euclid Ave, Cleveland, OH 44106 (e-mail: gerald.mahoney@case.edu).*

nervous system by guided practice of typical motor patterns (Butler & Darrah, 2001).

The Dev Skills interventions focus on learning and mastering the normally sequenced motor milestones, with intervention targets identified from skills at the next higher level (eg, Hanson & Harris, 1986). Instructional strategies tend to be behavioral in nature, that is, children are encouraged to engage in exercises or structured play activities that target specific skills. The Dev Skills approach assumes that children will advance to higher levels of motor development and independent functioning through guided practice and reinforcement. This approach is reflected in several commonly used early intervention scales and accompanying domain-specific curricula. Examples include the *Portage Guide to Early Education Program* (Bluma, Shearer, Froman, & Hilliard, 1976); the *Hawaii Early Learning Profile* (Furuno et al., 1998); and the *Peabody Developmental Motor Scales and Activity Cards* (Folio & Fewell, 1983).

While our study was designed to compare the relative merits of these 2 approaches, our primary purpose was to understand their impact as they were implemented in typical practice rather than controlled experimental conditions. Thus, we followed a group of children who received services from community-based early intervention or therapy programs that identified their treatment models as being based on either the NDT approach ( $n = 28$ ) or the Dev Skills ( $n = 22$ ) approach. We expected that these 2 groups would use similar procedures, but place greater emphasis on the methods and focus of the intervention model with which they identified.

To assess the merits of these 2 models, we examined their impact in relationship to motor impairments associated with different etiologies. For each treatment model our sample included children with Down syndrome ( $n = 27$ ) who tend to have delayed motor development associated with hypotonicity, and children with cerebral palsy ( $n = 23$ ) whose motor delays are associated with a range of atypical motor patterns. We hypothesized that the Dev Skills approach would be more effective

with children with Down syndrome because motor impairments associated with this condition are not severely affected by atypical motor patterns, whereas NDT would be more effective with children with cerebral palsy because of its focus on atypical motor patterns.

We also examined how several intervention and family factors mediate or contribute to the effects of these 2 treatment models. The effects of any intervention are unlikely to be simply a function of the nature of the intervention, but rather are likely to be mediated by a complex set of factors (Guralnick, 1997, 2001). These factors include the following: the training of interventionists, frequency of services, comprehensiveness of the program, and the manner in which the parents are involved in services. Because parents play a major role in fostering their children's development as well as implementing intervention activities at home, we examined how factors such as the level of support for parents and the way that parents, primarily mothers, interact with their children contributed to motor intervention outcomes.

In summary, our study compared the effects of NDT and Dev Skills motor intervention with a sample of 50 children who had either Down syndrome or cerebral palsy who attended 9 community-based intervention programs located in different regions of the United States. We examined changes in the rate of motor development and quality of movement from approximately 1 year of age ( $M_{CA} = 14.2$  months) over a 12-month period. We also examined how children's etiology and family characteristics, including family functioning, social support, and parent-child interaction, contributed to motor intervention outcomes.

## WHAT WE FOUND

### Diversity of motor intervention treatment models

As anticipated, there was considerable overlap between the treatments provided by NDT and Dev Skills interventionists. Both

groups focused on addressing specific motor skills, tone/posture/alignment, quality of movement, and general motor activity or play. Although the predominant focus of both treatment models was on the development of specific motor skills, 60% more NDT sessions focused on tone/posture/alignment, whereas 70% fewer sessions focused on general motor activity or play compared to the Dev Skills group.

Both intervention models were conducted in a range of settings (home/clinic/classroom), with different types of providers, different durations of sessions, and within early intervention programs that varied substantially in the amount of services children and families received (eg, stand-alone therapy, focusing on motor development vs comprehensive early intervention program). Dev Skills sessions were usually conducted by intervention specialists who were not physical therapists, whereas NDT sessions were delivered by physical therapists. Dev Skills sessions tended to be longer than 45 minutes (78% vs 23%), and occurred more in children's homes (38% vs 2%) and less in clinics (8% vs 24%) or center-based classrooms (54% vs 74%).

These 2 treatment models were associated with striking differences in parent involvement. There were differences in the number of (a) sessions in which parents were present (73% for Dev Skills vs 41% for NDT); (b) sessions where recommendations were given to parents (80% Dev Skills vs 51% NDT); and (c) number of natural environment activities recommended to parents (58% Dev Skills vs 35% NDT). Mothers whose children received the Dev Skills intervention received significantly more information about their children, more suggestions about activities to implement at home, and more assistance obtaining other services.

### **Effects of intervention on rate of development and quality of movement**

To assess the impact of intervention on children's rate of motor development, we administered the Peabody Gross Motor Development

Scale (Folio & Fewell, 1983) at the beginning and end of intervention. On average, children had motor development quotients of 49 at the beginning of intervention (55 for children with Down syndrome; 42 for children with cerebral palsy) and 48 after 1 year of intervention (51 for children with Down syndrome; 44 for children with cerebral palsy). There were no significant pre-post differences in motor development quotients between children with Down syndrome versus children with cerebral palsy, or between children who received NDT versus children who received Dev Skills treatment.

We computed a Proportional Change Index (PCI, Wolery, 1983) to examine how children's rate of motor development during intervention compared to their rate of development prior to receiving the intervention. For the entire sample the average PCI was 1.00. This finding indicated that the average motor development rate children attained during intervention was equivalent to their rate of development prior to receiving the intervention. However, the distribution of PCI scores indicated considerable variability in developmental rate changes. During intervention, 44% of the children decreased their rate of motor development by more than 10% (44.4% for children with Down syndrome; 43.5% for children with cerebral palsy), 32% maintained their rate of development within a range of  $\pm 10\%$  (37% for children with Down syndrome; 26% for children with cerebral palsy), and 24% increased their rate of development by more than 10% (18.5% for children with Down syndrome; 30% for children with cerebral palsy). This pattern of developmental change did not vary significantly as a function of the type of intervention model children received or children's diagnosis (cerebral palsy vs Down syndrome). While NDT produced slightly better PCIs than did the Dev Skills intervention (1.08 for NDT; 0.92 for Dev Skills), these differences were not statistically significant.

We assessed changes in the quality of children's movement by using items from The Toddler Infant Motor Evaluation (TIME, Miller

& Roid, 1994) to rate several components of movement from videotaped observations of children in multiple positions at the beginning and end of intervention. Because this use of the TIME was not a standardized procedure, we were unable to determine how observed changes in quality of movement compared to changes that might be expected because of maturation. However, the quality of movement findings were generally consistent with the results for rate of development. During intervention, the group of children as a whole improved their quality of movement, but on average only at a level consistent with their quality of movement at the beginning of intervention. In general, improvements appeared to be equivalent for children with Down syndrome and children with cerebral palsy, regardless of whether they received the NDT or the Dev Skills treatment models.

#### **Do characteristics of intervention affect motor intervention outcomes?**

Several analyses were conducted to identify characteristics of interventions that might contribute to motor intervention outcomes. Results suggested that factors such as the professional training of interventionists (eg, intervention specialist vs licensed physical therapist vs licensed physical therapist with NDT training), the degree to which program staff worked with parents, the location of services, and the comprehensiveness of services families received did not affect the children's motor intervention outcomes.

However, one finding was statistically significant. Although children had been scheduled to receive at least 1 intervention session each week, there was considerable variability in the number of sessions they actually attended. Number of sessions was the only variable, other than children's level of motor functioning at the beginning of intervention, which was a significant predictor of children's motor development improvement during intervention. In a post hoc analysis of children grouped according to the number of sessions attended, we found that high-attendance children ( $n = 23$ ; Mean = 56.0; SD = 17.1)

attained a 14% increase in their motor development rate while low-attendance children ( $n = 22$ ; Mean = 19.0; SD = 8.1) had a 17% decrease in their motor development rate. High- and low-attendance groups were not different with respect to diagnoses, type of treatment model, or level of motor functioning at the onset of intervention.

#### **Do family characteristics affect motor intervention outcomes?**

Measures of family functioning, social support, and parent-child interaction were also collected at the beginning and end of intervention to determine how these factors contributed to intervention outcomes. Because of the lack of statistically significant relationships between these variables and children's motor development outcomes, none of these findings were included in the original report. Regression analyses indicated that neither the family environment or the social support measures collected at preintervention and post-intervention nor mothers' style of interaction at preintervention was significantly related to children's motor improvements. While maternal directiveness at postintervention was negatively associated with children's motor improvement, it accounted for only 2% of the variance in their rate of development. We were unable to determine the relevance of this finding to intervention, since neither treatment model caused mothers to become more directive, and the effects of maternal directiveness on motor development did not differ between the 2 treatment models.

### **DISCUSSION AND RECOMMENDATIONS**

*Contemporary treatment methods may not be effective at achieving the goals envisioned for early motor intervention?* Consistent with findings from previous studies (Bower, Michel, Burnett, Campbell, & McLellan, 2001; Harris, 1997; Palmer, 1997; Palmer et al., 1991), results from this study present a sobering picture of the benefits that children

with Down syndrome and cerebral palsy attained from participating in motor intervention. Whether children received services based upon the NDT or Dev Skills treatment models, on average their rates of motor development did not change during intervention. Our analyses of motor intervention outcomes in relationship to variables hypothesized to contribute to the effectiveness of services revealed that only "number of sessions" contributed to children's outcomes.

It is possible that the omission of a no-treatment control group in this study resulted in our underestimating the significance of our finding that nearly one third of our sample sustained, rather than decreased, their rate of developmental growth. Maintenance of the same rate of growth as at baseline may be a legitimate outcome for some children with disabilities. Yet, is the magnitude of this effect sufficient in relation to the expense, time costs, and disruptions to family routines of individual "therapy" appointments, whether they are in clinics or classrooms (Kaminer & Robinson, 1993; Snow, 2002)? We suspect that few parents of children with disabilities or funders of service would be complacent with such modest effects.

Our results add to the accumulating evidence that the treatment methods currently used in early motor intervention are weak at best, and fall far short of the hopes and vision upon which this endeavor was originally based (Ketelaar, Vermeer, 't Hart van Petegem-van Beek, & Helders, 2001; Weindling et al., 1996). We do not serve the children and families we so passionately care about by discounting disappointing research findings and sustaining the status quo. As professionals we must acknowledge that although we need to continue serving children with motor impairments and their families using the best clinical methods available, at the same time, we must become much more aggressive in our efforts to develop, evaluate, and integrate more effective treatments into practice.

*There is a critical need to take seriously the role of parent involvement in motor in-*

*tervention.* Almost 25 years ago, Bronfenbrenner (1979) concluded from a review of Head Start Programs that early intervention effects were associated with the degree to which programs worked directly with parents. Bronfenbrenner observed that young children's learning is not restricted to instructional activities that take place in clinics or classrooms, but rather occurs throughout their daily environments. Parents have more opportunities to promote children's development and participation in these environments than do professionals. Although Bronfenbrenner's conclusions were based upon evaluations of children who were at risk for developmental delays, there is no reason to believe that his conclusions do not apply to infants and toddlers with disabilities as well.

A few years ago, we published an analysis of the developmental outcomes that 635 infants and toddlers with, or at risk for, disabilities attained in 4 intervention research projects that provided compelling support for Bronfenbrenner's thesis (Mahoney, Boyce, Fewell, Spiker, & Wheeden, 1998). Results indicated that when early intervention not only worked with parents but also helped them learn more effective ways of interacting with their children, it successfully promoted children's general development. However, when intervention did not help parents interact more effectively with their children, it had little impact on children's developmental growth, regardless of the intensity of services children and families received.

During the last 5 years, a number of articles related to parent involvement in motor intervention have been published. These articles have argued for parents playing a more central role in motor intervention (Darrah, Law, & Pollack, 2001); provided data indicating that parents are comfortable with this role (Sayers, Cowden, & Sherrill, 2002); and demonstrated that parent involvement can have a positive impact on motor intervention effectiveness (Hamilton, Goodway, & Haubenstricker, 1999; Ketelaar, Vermeer, Helders, & Hart, 1998; Torres & Buceta, 1998).

While the interventionists in our study reported working with parents, there was considerable variability in what they did and how much they worked with them. Furthermore, these interventionists were not successful at helping parents acquire patterns of interaction that might be more effective at promoting children's motor growth. In spite of their efforts to work with parents, their interventions tended to be more professionally driven than parent mediated. Parents were not present for almost 50% of all sessions, and only 18% of the sessions took place in children's homes or natural environments.

Certainly one plausible explanation for the disappointing outcomes observed in our study was the fact that interventionists carried out their role more by working directly with children as opposed to working collaboratively with parents. Very likely, this situation did not occur by design, but resulted from a variety of factors that are known to limit parent involvement. Perhaps many parents were unable to participate because of job or other family responsibilities; some may have resisted becoming involved; while for others, interventionists may have refrained from attempting to involve parents fearing that this would unduly stress or overwhelm them.

Particularly in light of the Individuals with Disabilities Education Act (IDEA) Part C mandate for early intervention "to enhance the capacity of families to meet the special needs of their infants and toddlers," the time has come to stop talking about parent involvement and to commit to learning how such involvement can be accomplished across a range of family constellations, circumstance, and values. This is not a simple shift. It will require us to conduct research to help us better understand how parents actually influence children's motor development. It will also require us to develop service delivery options and intervention procedures that are less stressful and more accommodating to parents. Service and funding agencies must stop conceptualizing motor intervention as the activities professionals do to children, and begin to take seriously the idea that intervention fundamen-

tally entails empowering parents and others to support children's motor development in their daily routines (Kaminer and Robinson, 1993; Mahoney et al., 1999).

*We need to become more active in pursuing a national/international motor intervention research agenda.* Although we maintain that parent involvement is essential for effective motor intervention, parent involvement will be beneficial only if they are provided recommendations and motor intervention strategies that are truly effective.

In reviewing the results from our own study as well as results from other recently published motor intervention studies, we cannot help but wonder whether there might be fundamental flaws with the treatment methods and strategies used in contemporary practice. If the procedures examined in our study were valid, one or the other treatment models should have worked under one or a combination of the conditions we examined (eg, diagnosis, service setting, comprehensiveness of services, professional training of interventionists), but they did not. For too long researchers have been apologetic about reporting negative intervention results, cautioning that their failure to find treatment effects could be attributed to flaws in the analyses, such as inadequate assessment measures, nonexperimental research designs, and small sample sizes (Harris, 1997; Palmer, 1997). However, a recent review by Seibes, Wijnroks, and Vermeer (2002) reported that the quality of motor intervention research reported in the 1990s improved dramatically from the research reported in the 1980s, but still there was little, if any, improvement in motor intervention outcomes.

Aside from a few recent promising programs of research, the most notable feature of contemporary motor intervention research is the lack of it. Harris's review of motor intervention for young children with cerebral palsy provides a startling illustration of this observation (Harris, 1997). Over a 10-year time period (1987–1997), she identified fewer than 10 published studies investigating these issues. This would not be so alarming if clinical

procedures yielded consistent, positive treatment effects, but such results are not the case.

However, there are at least 2 areas of research that hold promise for enhancing the effectiveness of motor intervention procedures. The first is related to the issue of "intensity" of services. Similar to findings reported by Mayo (1991), results from our study yielded only one significant intervention effect, and this was related to the intensity of services children received. Regardless of children's diagnosis or the type of treatment they received, children who were high attenders made significantly greater increases in their rate of motor development than did children who were low attenders. The question of how much service children must receive to attain an intervention effect is an issue that, if not addressed by research, will continue to be dictated by arbitrary decisions made by administrators and funders of services.

While our findings related to intensity were provocative, they were also perplexing. Our high attenders who averaged slightly more than 1 session per week made modest motor improvements, while our low attenders who averaged approximately 1 session every 3 weeks showed no intervention effect at all. If, as these data imply, there is truly a "dosage" effect to motor intervention, than perhaps our failure to find meaningful intervention effects is the result of children not receiving sufficiently intensive services.

On the other hand, since the frequency of services received by the high attender group can hardly be characterized as "Intensive," particularly compared to the 15 to 40 hours of weekly intervention services recommended for children with autism (Dawson & Osterling, 1997), it may be that the effect we observed had little to do with the intensity of services children received. Rather, this effort may have been related to children having different numbers of opportunities for motor learning, not only in intervention but in their natural environments as well. Consistent with the notion of parent involvement discussed above, it is possible that the different attendance rates of the high and low attenders may have been a

reflection of the different levels of personal investment these 2 groups of parents had in ensuring their children's general opportunities for motor learning. In either case, intensity of service is an intervention factor that is one of the most critical issues facing parents and administrators. It is absolutely essential that research be conducted to guide decisions related to this factor.

A second promising line of research is related to the use of Dynamic Motor Theory (Thelen & Ulrich, 1991) as a foundation for the development of intervention procedures. This theory views motor development as a process by which children construct solutions to motor problems. New motor behaviors evolve from children using their unique characteristics and capacities to explore situations through which they discover new and more adaptive forms of gross motor behavior. To accomplish such tasks, infants must attend to the information generated by their own bodies as well as the information available in the context. This theory of motor learning not only highlights the importance of child-initiated motor activity but also emphasizes that children's intrinsic dynamics (eg, active learning) play a major role in the acquisition of more adaptive motor behaviors.

The implications of this theory for practice have yet to be fully delineated (Case Smith, 1996). Nonetheless, this theory challenges the value of clinical motor intervention procedures that emphasize passive movement exercises and didactic instruction of motor skills. One promising line of research to evolve from this tradition is the work of Ulrich and his colleagues investigating the effects of spontaneous stepping practice on the rate that children with Down syndrome learn to walk (Ulrich, Ulrich, Angulo-Kintzler, & Yun, 2001). In addition to receiving traditional physical therapy, parents provided their children with practice stepping 5 days a week for 8 minutes each day by supporting them on specially engineered miniature treadmills. The intervention began when children were approximately 10 months old and continued until they were independent walkers.

A Treatment versus No Treatment research design indicated that this type of spontaneous stepping practice helped children with Down syndrome walk independently approximately 100 days sooner than did the children who did not receive the treatment.

Consistent with the principles of Dynamic Motor Theory, the Ulrich study demonstrates the potential influence that spontaneous movement can have on children's motor learning. If such robust effects can occur when children receive only modest (8 minutes per day) amounts of arranged practice, might not more dramatic effects occur if we enhance children's spontaneous activity throughout their daily routines? Research reported by Hanzlik and Stevenson (1986) may provide an important clue as to how this result could occur. These investigators reported that young children with cerebral palsy engaged in greater amounts of spontaneous motor activity when their mothers interacted responsively rather than directly with them. Perhaps Functional Physical Therapy (Ketelaar et al., 2001) can become a more potent intervention if we conceptualize functionality in terms of adults interacting responsively to support and encourage children to engage in the motor activities that interest them throughout the day (Okimoto, Bundy, & Hanzlik, 2000).

### **Policy and funding barriers to recommended practice**

While we did not gather data regarding funding of services in our study, we do have a great deal of anecdotal data as to how funding sources and policies impact service models. For example, in Colorado, during the time of this study, funding from Medicaid paid a more favorable rate to hospital-based outpatient therapy departments than to individual providers. To be reimbursed at the more favorable rate, the service had to occur on site in the clinic, an approach that contravened the mandate to provide intervention in the home or in places where one would expect to find children without disabilities, ie, "natu-

ral environments." Home-based services could only be funded by Medicaid if the child was too fragile to transport. In addition, the rate paid to a Home Health Agency was based upon a fixed charge for a procedure rather than billing for time, which was the case for clinic-based services. The "Home Health" procedure rates were typically developed based upon adult models where a visit might be for providing 20 minutes of range of motion exercise. These rates did not adequately compensate recommended activities such as instruction of the parent in problem solving around daily care routines or visiting the neighborhood park to see what adaptations might be provided to enable a child to play with other children.

Use of a transdisciplinary model that is recommended for its presumed efficiencies in resource allocation and potential for providing a better coordinated intervention is often contravened in policy and funding, because it is not possible to recover costs of the lead interventionist receiving consultation from colleagues in other disciplines. Providing instruction to parents and other caregivers is constrained by policies that are perceived as stipulating that only services that involve direct "hands on" activities with the child are "billable time." Undoubtedly, perceived and real barriers such as these contributed to the limited instruction of parents that we observed in our study. Reimbursement policies favoring direct hands-on intervention more than consultation have been a driving force for a professionally driven, "pull out" model of therapy.

### **CONCLUSION**

The purpose for reviewing the results from our study was not to dwell on the negative, but to emphasize the critical need for research and development related to early motor intervention. Recommendations from the National Research Council Committee on Educational Interventions for Children with Autism (Lord & National Research Council Committee on Educational Interventions for Children

with Autism, 2001) offers an excellent template for the issues to be addressed to enhance the effectiveness of motor intervention services. Specifically, this committee articulated the need for (1) detailed description of characteristics of both children and families with whom interventions are implemented; (2) manualization of treatments; (3) assessments of the fidelity of treatment implementations; and (4) documentation of child progress in both acquisition and generalization of skills.

In addition we recommend that this work be guided by the ICF framework (WHO, 2001) to gain clarity regarding the purpose and outcomes of specific interventions. Funding policies are needed to support the expectation for intervention services to include collaboration with parents, as well as to provide the adaptive equipment and assistive technologies needed to ensure that children with motor impairments can participate in typical routines.

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