Cognitive Orientation to Daily Occupational Performance (CO-OP): Part II– The Evidence

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SUMMARY. CO-OP is a child-centred, cognitive based intervention, focused on enabling children to achieve their functional goals. It has

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Funded by the Cloverleaf Charitable Foundation.

[Haworth co-indexing entry note]: "Cognitive Orientation to Daily Occupational Performance (CO-OP): Part II–The Evidence." Polatajko, Helene J. et al. Co-published simultaneously in *Physical & Occupational Therapy in Pediatrics* (The Haworth Press, Inc.) Vol. 20, No. 2/3, 2001, pp. 83-106; and: *Children with Developmental Coordination Disorder: Strategies for Success* (ed: Cheryl Missiuna) The Haworth Press, Inc., 2001, pp. 83-106. Single or multiple copies of this article are available for a fee from The Haworth Document Delivery Service [1-800-342-9678, 9:00 a.m. - 5:00 p.m. (EST). E-mail address: getinfo@haworthpressinc.com].

been developed over the last nine years through a series of systematic studies that have specified the treatment protocol and evaluated its effect. Initially CO-OP was explored in two series of single case experimental studies. Subsequently, an informal follow-up study and a detailed analysis of the video-taped sessions of the approach were completed. Based on information from these studies, the approach was refined, key features elucidated and the protocol was specified. Next, a pilot randomized clinical trial was completed. The trial was conducted to determine how best to approach a full scale randomized clinical trial on the effectiveness of CO-OP, relative to the current therapeutic approach. Finally, a retrospective chart audit was carried out to examine the cumulative evidence on the effectiveness of CO-OP in improving the performance of children with DCD. This paper presents a detailed summary of these five studies and discusses the implications of the findings.

KEYWORDS. Evidence-based practice, motor learning disability, cognitive intervention, DCD

School-based health professionals receive a large number of referrals for children who exhibit mild motor or sensory motor problems that interfere with their performance at school. Often these children exhibit problems of sufficient severity to warrant the diagnosis of Developmental Coordination Disorder (DCD). ''The essential feature of Developmental Coordination Disorder is a marked impairment in the development of motor coordination . . . that significantly interferes with academic achievement or activities of daily living.''[1] In the past, children with DCD were provided intensive treatment for extended periods of time in clinics or schools.[2-4] Recent cutbacks in funding have seriously reduced services to these children. The rationale provided for cutting services has included issues of large numbers, the high cost of treatment, relatively small treatment effects, and the presumed unimportance of the problem. However, contrary to previous beliefs that this is a benign childhood condition, it is now clear from longitudinal studies that the condition persists into adulthood[1] and that there can be serious long-term sequelae.[5-8] Children with DCD are at risk for increased reliance on educational, social, mental health, vocational and economic services as they develop. Effective management of this condition is, therefore, an important health issue.

The approach to the treatment of children with DCD, traditionally, has been based on sensory-motor (reflex-hierarchical) models of motor development which focus on decreasing motor impairment (see Mandich et al., this volume, for a discussion). For several reasons, these approaches, which stem from the 'therapeutic concept of rebuilding control of the motor system,' (p. 14)[9] are now being reexamined. First, studies investigating the effectiveness of these approaches, for the most part, have failed to demonstrate any significant effects due to treatment[10-13] with most investigators reporting small, or no treatment effects.[14-19] Second, contemporary literature on motor learning and control suggests that the reflex-hierarchical model does not adequately explain skill acquisition and performance. Rather, current theories of motor learning emphasize the importance of the interaction of the person, the task and the environment in skill acquisition. The focus of treatment, therefore, should be on task performance.[20-23] In keeping with this, a number of experts have suggested that cognitive, or problem-solving approaches, should be considered in the treatment of children with DCD.[24-27] Finally, as reflected in current practice,[2] therapists are searching for effective alternatives that are quicker and more portable than the traditional approaches.

In 1991, Polatajko and colleagues[28] began to search for a new approach to children with DCD. It was considered that Meichenbaum's cognitive behavioural[29,30] approach, based on verbal self instructional training, was promising because it focussed on skill building, had been used effectively with other children with similar difficulties, and was consistent with contemporary thoughts on motor learning. This new approach, called Cognitive Orientation to daily Occupational Performance (CO-OP), combines Meichenbaum's cognitive behavioural approach with a client-centred framework[31] and the mediational techniques of Feuerstein and colleagues.[32-34] The CO-OP approach is a highly individualized one in which children are guided in the use of a global problem-solving strategy and the identification of domain-specific strategies that will enable new and effective ways of achieving their individually chosen functional goals.

Over the past nine years, Polatajko and colleagues have undertaken a program of study designed to develop and evaluate CO-OP. Initially CO-OP was explored in two series of single case experimental studies. Because of the heterogeneity of the DCD population, it was determined that a single case experimental design was the research para-

digm of choice for exploring the efficacy of this new treatment. Further, single case experimental design, with direct replication, is a good method for developing a new treatment protocol and initially evaluating a treatment effect.[35]

The first series of single case experimental studies (SCES), carried out by a single therapist, included 10 children.[36,37] This allowed for one original experiment and nine direct replications, exceeding the recommended number of replications.[35] It was felt important to have a large enough sample to conduct a preliminary investigation of the transferability of the effect. Thus, the first series of SCES included a within-group design component, using standardized measures of related behaviours, administered by an independent assessor.

Ottenbacher[38] pointed out that the generalizability of a treatment effect needs to be demonstrated across clients, settings, and therapists before a treatment can attain broad acceptance. Ottenbacher described three phases to establish the generalizability of SCES results. In phase one, several direct replications must be conducted to establish a potential treatment effect. This first phase of generalizability was satisfied by the successful single case experiment with one child and the direct replications with nine other children conducted by the therapist in the series one SCES.[36,37] The second phase of generalizability requires replication across, clients, settings and therapists. This was satisfied by Martini and Polatajko,[39-41] by conducting a systematic replication with four additional children. Subsequently, an informal follow-up study[42] and a detailed analysis of the video-taped sessions of Studies I and II[43-45] were completed. Based on the information from these studies, the approach was refined, key features were elucidated and the protocol was specified. Next, a pilot randomized clinical trial[46] was completed. The trial was conducted to determine how best to approach a full scale RCT on the effectiveness of CO-OP, relative to the current therapeutic approach. This satisfied Ottenbacher's third phase of generalizability, showing clinical replication of the treatment effect and also provided evidence of the effect of CO-OP as compared to current treatment practices. Finally, a retrospective chart audit was carried out to examine the cumulative evidence on the effectiveness of CO-OP in improving the performance of children with DCD. The purpose of this paper is to present a detailed summary of these five studies and to discuss the implications of the findings.

STUDY I: SINGLE CASE EXPERIMENTS- SERIES ONE AND WITHIN-GROUP STUDY

The use of a cognitive approach in the treatment of the performance problems of children with DCD, initially called Verbal Self Guidance (VSG), was first explored by Wilcox and Polatajko[36, 37] in a series of single case experiments. One original single case experiment and nine direct replications were carried out to determine if the global problem-solving strategy, adapted from Meichenbaum's[29, 30] cognitive behavioural approach, could be used to improve the performance of children with DCD. As well, a within-group design was used to examine skill acquisition and to explore skill transfer.

The specific research questions addressed were[36]:

> Can children with DCD learn the global problem-solving strategy?
> Can children with DCD use the global problem-solving strategy to acquire the skills to perform three activities of their choice?
> Once learned, are the performance skills maintained?
> Does performance improve in other areas?

The sample consisted of 10 children, 4 girls and 6 boys, referred to occupational therapy for motor problems, all of whom recently had been involved in a randomized clinical trial of the process oriented treatment approach.[16] Four had been in the control group in the previous study, three in the process oriented treatment group, and two in the traditional treatment group. All children met the DSM-IV[1] criteria consistent with a diagnosis of DCD, were between the aged of 7-12 years, were of normal intelligence, had normal or corrected vision and hearing, and were identified by an occupational therapist as exhibiting motor problems. Children with neurological disorders were excluded. The 10 children and their families volunteered to attend treatment during the summer.

The children participated in 13, 50 minute, one-to-one sessions (1 baseline, 10 treatment, 1 post treatment, and 1 follow-up, 12 weeks post treatment), all conducted by a single therapist. In the first session the COPM was used to help children identify the three skills they needed, wanted, or were expected to perform that were difficult for them. Children were videotaped performing each of the three tasks, repeatedly, for baseline purposes. An attempt was made to have at

least three repetitions of each behaviour, where possible. No attempt was made to have more frequent repetitions for baseline as it was felt that it was inappropriate to ask a child to repeatedly demonstrate failure on an activity that has been identified by the child as something that he or she cannot perform. In the following session they were taught Meichenbaum's global problem solving strategy, goal-plan-do-check. This is a four-step, problem solving strategy that teaches children to identify a goal, to state their plan for achieving it, to do the activity and then to check how successful they were. Throughout the 10 treatment sessions, Meichenbaum's self-instruction training concepts were used and the children were actively encouraged to use the goal-plan-do-check strategy to verbally guide themselves in learning to perform the three skills they had chosen. A puppet, Mr. GoalPlanDoCheck, was introduced to the children as the president of a detective club. The children were invited to become members and solve the performance mysteries of the skills they had chosen to learn. Parents were invited to be present throughout, either in the room or on the other side of a one-way mirror. All sessions were videotaped.

The outcome measures used for the single case experiment component of the study were based on behavioral observation. For each child-chosen skill, percentage of time actively spent on-task, duration of the task performance, and performance quality were recorded by the investigator, using the video taped recordings of the baseline session, the treatment sessions, the post-treatment probe session and the follow-up session. In order to rate performance quality operational definitions were created and a scale was designed to rate performance quality. In all, 30 operational definitions and task specific quality performance rating scales were created for the 30 skills chosen by the children (see Table 1). Criteria were established for successful performance of each activity. For example, for the activity ''handwriting,'' the criteria for a given child might have been: writes on line, forms all letters properly, appropriate spacing between words, legible product. The performance rating scale was as follows: 0 = met no criteria; 1 = met some criteria, poor quality of performance and product; 2 = met most criteria, poor quality of performance and product; 3 = met most criteria, fair quality of performance and product; 4 = met all criteria, fair quality of performance and product; 5 = met all criteria, excellent quality of performance and product.

The standardized measures used for the within-group design were: the Canadian Occupational Performance Measure (COPM),[47] which addressed the issue of skill acquisition, and the Vineland Adaptive

TABLE 1. Study I and II: Activities Chosen by the Children

Child	Activity One	Activity Two	Activity Three
STUDY I			
1	shuffling playing cards	slicing cheese, tomatoes, buns	writing capital letters
2	baking “good for you” cookies	cutting meat and bread	writing faster, “with the need for fewer corrections”
3	applying nail polish	shampooing hair	printing, beginning writing
4	making a dragon kite	writing speed, legibility	making a bed
5	folding paper “straight”	cutting paper	forming and joining letters
6	performing a karate kata	using chopsticks	making french toast
7	making hamburgers	writing numbers	playing baseball
8	writing capital letters	pitching a slo-pitch ball	sewing with needle/thread
9	cutting food with cutlery	printing	catching small balls
10	alphanumeric keyboarding	running cross-country “better”	copying numbers from blackboard
STUDY II			
1	hitting hockey targets	printing capital and small letters	twirling spaghetti on a spoon
2	making ice cream	typing on computer	throwing basketball into net
3	performing a karate kata	running faster	cutting cucumbers
4	skipping rope	printing capital and small letters	making paper airplanes

Note: Quotation marks indicate child’s description

Behaviour Scales (VABS),[48] the Developmental Test of Visual Motor Integration (VMI),[49] the Test of Motor Impairment (TOMI),[50] the Child Behavior Checklist/4-18,[51] and the Eyberg Child Behaviour Inventory,[52] which explored issues of generalization and transfer. All measures, except for the COPM, were administered by an independent assessor at baseline and at follow-up, 12 weeks post treatment. The COPM, which is considered as much a part of the intervention as an outcome measure, was administered by the therapist on three occasions: at baseline, post treatment, and at follow-up.

While it is beyond the scope of this paper to present all the results of this study, the more germane data are presented here, i.e., the results addressing skill acquisition and transfer to adaptive behaviour and performance.

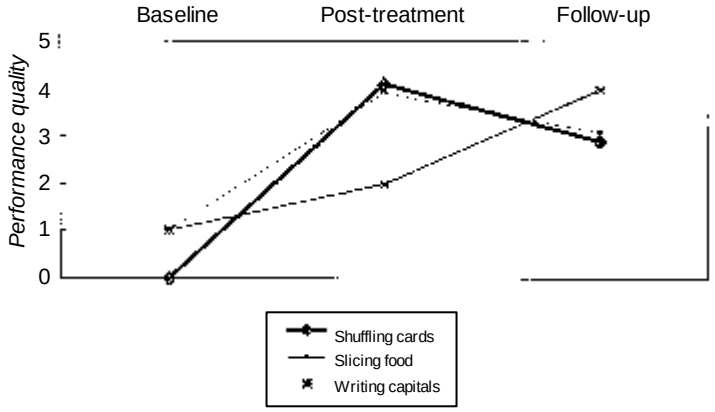
Skill acquisition was addressed in the single case experiments. For child 1, the first participant in the study, the single case data showed an important increase in performance quality between baseline and follow-up, for all three activities. For two activities, the increase was greatest between baseline and post-treatment, for the third activity it was greatest between post-treatment and follow-up (see Figure 1). This effect was replicated across nine children. The data for eight of the other children were similar, showing improvements in performance quality over baseline for 23* of 24 activities. One child** made only small to moderate gains. In sum, the single case data showed that 10 out of 10 children improved their performance on their chosen activities and maintained their performance 12 weeks after the end of treatment. Nine out of the 10 children learned to meet all performance criteria for their chosen skills with fair or excellent quality and showed maintenance 12 weeks later. This held true across 29 out of the 30 activities chosen by the children.

The COPM[47] also addressed the question of skill acquisition, on a group basis. These data mirrored the observational data, providing validation of the observational data. The children, as a group, across all 30 activities, reported dramatic improvements in performance and satisfaction for their chosen activities. The group means rose from 2.2 and 2.5 on performance and satisfaction, respectively, at baseline, to

*One child met all performance criteria for one of his three chosen activities at baseline.

**This child did not attend the full number of sessions and attended sporadically for the sessions he did attend. He was not present for the post-treatment session, but was present for follow-up.

FIGURE 1. Study I Outcome



9.2 and 9.5, respectively, at post-treatment, to 8.7 and 8.9, respectively, at the 12 week follow-up (see Table 2). All differences between baseline and post-treatment and baseline and follow-up were significant. The differences between post-treatment and follow-up were not significant, indicating maintenance of the skills learned. Thus both the observational data and the COPM data indicated that the children learned to perform the three activities they had found difficult and maintained their skills 12 weeks post treatment.

Transfer of skills was explored using the COPM, VABS, VMI, and TOMI. The results for these were also promising. The VABS,[48] showed significant improvement, as the COPM had done. This indicates that the improvements in performance were not limited to the skills focused on in treatment. Transfer to specific motor skills, explored with the VMI,[49] and the TOMI,[50] is less clear. Changes, when they occurred, were in the expected direction, but the differences in scores between baseline and follow-up did not reach statistical significance. Given the limited power related to the small sample size, this result is difficult to interpret. It may indicate a lack of transfer or an inadequate sample size. Post hoc power analyses indicated an effect size (*d*) of .16 for the VMI, and .62 for the TOMI. By Cohen's criteria[53] these effect sizes are considered small and medium, respectively. For the VMI, this would suggest that the nonsignificant finding was due to a lack of transfer. In contrast, TOMI's data not reaching significance was probably due to insufficient sample size.

TABLE 2. Study I- Within-Group Outcomes (N = 10)

	Pre-test M *(SD)*	Post-test M *(SD)*	t Pre-Post	Follow-up M *(SD)*	t Pre-Follow-up
COPM+					
Performance	2.2 (1.6)	9.2 (1.4)	□ 17.07**	8.7 (1.8)	□ 14.46**
Satisfaction	2.5 (1.6)	9.5 (1.1)	□ 14.48**	8.9 (2.1)	□ 12.6**
VINELAND					
Composite	69.9 (10.6)			85.2 (14.6)	□ 5.18*
Communication	65.1 (12.0)			79.5 (18.6)	□ 3.38*
Daily Living Skills	81.6 (8.4)			90.4 (10.9)	□ 3.43*
Socialization	79.0 (14.4)			95.7 (14.3)	□ 6.69**
TEST OF VISUAL-MOTOR INTEGRATION (VMI)					
	84.3 (10.9)			81.9 (10.1)	0.52
TEST OF MOTOR IMPAIRMENT (TOMI)					
Total Raw Score	7.1 (3.5)			6.3 (2.4)	0.35
Manual dexterity	3.2 (2.0)			2.2 (1.9)	
Ball skills	1.0 (1.4)			1.2 (0.8)	
Balance	3.0 (1.2)			2.9 (1.1)	

*p < .05
**p < .01
+ COPM was administered on three occasions, the other measures were administered on two occasions.

To conclude, the results of series one were promising. The first single case experiment indicated that children with DCD could learn to use a global problem-solving strategy which could be used to acquire skills that are difficult for these children and that these skills are maintained. The nine direct replications showed that this was a reproducible effect and provided some evidence of skill transfer. Further development and testing of this cognitive approach was indicated.

STUDY II: SYSTEMATIC REPLICATION

Martini[39-41] carried out a systematic replication of the single case experiment component of Study I. The purpose of Study II was to determine if the results obtained in Study I could be replicated by another therapist with four new children with DCD. Using a systematic replication approach, one original single case experiment and three replications were carried out, as recommended by Hersen and Barlow.[35] The basic research question addressed was:

> *With another therapist*, can children with DCD learn a global problem-solving strategy and use it to learn to perform three activities of their choice?

As in Study I, all children, one girl, three boys, met the DSM-IV criteria consistent with the diagnosis of DCD, were between the ages of 7-12 years, were of normal intelligence, had normal or corrected vision and hearing, and were identified by an occupational therapist as exhibiting features of DCD. Children with neurological disorders were excluded.

The measures used included the COPM,[47] the Performance Quality Rating Scale (PQRS),[39] a five-point behavioural observation scale used to rate the quality of activity performance, time on task, percentage correct use of the Goal-Plan-Do-Check (GPDC) strategy, and evidence of metacognition as reported by the children in response to questions probing strategy use. No attempts were made to address the question of maintenance and transfer in Study II.

The procedures used were the same as those in Study I with the addition of establishing inter-rater reliability for the behavioural observations. The therapist was trained in the cognitive approach by the authors of Study I. As no formal written treatment protocol existed,

the therapists began training by reading about cognitive behaviour modification and viewing the videotapes of Study I and discussing key points. The therapist was video-taped and received supervision throughout the implementation of the approach.

The findings of Study I were replicated by the PQRS and COPM results (see Table 3). The children identified similar activities (see Table 1); learned the global strategy, used it to acquire their chosen skills, improved their performance and reported improved performance and satisfaction. Thus, the systematic replication was successful and provided evidence that the CO-OP approach was generalizable across therapists (see Martini & Polatajko, 1998, for a complete description[41]).

STUDY III: INFORMAL FOLLOW-UP AND VIDEO TAPE ANALYSIS

Given the positive results of Studies I and II, it was decided to pursue the development of CO-OP. First, an informal follow-up with the children from Studies I and II was carried out.[42] Using an open-ended telephone questionnaire, an independent interviewer spoke with the parents of the children who had participated in Studies I and II. Parent reports indicated that the children continued to have the skills over the two or more years since their CO-OP treatment. Often there were also reports of continued improvement and further skill development. However, continued use of the strategy did not occur spontaneously. Thus it was decided to include a parent participation component in the approach.

Next, a detailed analysis of the video-taped sessions from Studies I and II was conducted to identify the salient strategies of the approach.[43-45] Analysis of 140 hours of this therapy provided verification of the use of the global strategy in skill acquisition and pointed to the identification of 8 domain specific strategies that supported specific skill acquisition. While the global strategy seemed necessary for skill acquisition, it seemed to be insufficient. Frequently, domain specific strategies were required to enable the child to carry out the task (for details, please see Mandich et al., this volume[45]). Thus, the global cognitive strategy Goal-Plan-Do-Check (GPDC) seemed to be acting as a framework for the identification of the domain specific strategies necessary to complete the task. This finding not only supported the use

TABLE 3. Study II- Systematic Replication Outcomes

		Baseline Activity			Post-treatment Activity		
		1	2	3	1	2	3
PQRS[1] mean score	Child 1	2.3	2.5	2.5	4.5	4.5	5
	Child 2	0	.17	1.7	3	1.3	3.7
	Child 3	0	2	3	4	3.7	4.8
	Child 4	0	2	0	4.8	3	3.7
COPM[2]							
Performance	Child 1	1	2	3	10	10	10
	Child 2	2	3	2	10	9	10
	Child 3	5	2	4	10	10	10
	Child 4	1	2	1	10	10	10
Satisfaction	Child 1	1	2	3	10	10	10
	Child 2	1	5	2	10	10	10
	Child 3	5	1	1	10	10	10
	Child 4	1	1	1	10	10	10

[1] PQRS, Performance Quality Rating Scale, is a five-point scale, where: 0 is no activity criteria are met, and 5 is all activity criteria are met with good quality.
[2] COPM, is a ten-point scale, where: 1 is low and 10 is high.

of the approach, but more importantly, allowed for the elucidation of the strategies being used and the specification of the treatment protocol. At this point, the treatment approach, and its name, were changed to reflect these new findings. Moving from Verbal Self Guidance (VSG) to Cognitive Orientation to daily Occupational Performance (CO-OP), both the global problem-solving strategy and domain specific strategies were incorporated into the treatment protocol.

STUDY IV: CLINICAL REPLICATION-PILOT RCT

In 1998, Miller and Polatajko and colleagues carried out a pilot randomized clinical trial of CO-OP (see Miller et al.[48] for a detailed description). The objective of this pilot study was to determine the feasibility of a full scale RCT comparing CO-OP with the current treatment typically given to children with DCD. This study evaluated performance improvements on three tasks identified by the child as problematic and chosen by the child for the focus of treatment and generalization and transferability. The study was carried out using a random groups design with children randomly assigned to either the CO-OP or current treatment approach (CTA) groups. The current treatment approach is an eclectic combination of neuromuscular, multi-sensory, and biomechanical approaches.

Twenty children, six girls, 14 boys, between the ages of 7 and 12 (mean age of 9.05 years, *SD* = 1.23) participated in this study. All children had been referred to the university clinic for performance problems. All had normal intelligence, were identified by a therapist as having motor problems and met the DSM-IV criteria for DCD. All could identify three performance issues during administration of the COPM.

Three therapists, all experienced in working in the schools with children with motor problems. participated in the study: one, experienced with CO-OP, treated five children, using the CO-OP approach only; one, having no knowledge of CO-OP, treated five children using the CTA approach, only; and one, also with no a priori knowledge of CO-OP, used CTA with the first five children she saw, and then was trained in CO-OP for use with the next five children she saw. In both groups, the three treatment goals were child-chosen. In the CO-OP group, the treatment was carried out in the manner described in the

protocol (see Polatajko et al.,[28] this volume). The children in the CTA group participated in the same number of sessions as those in the CO-OP group. The content of the CTA treatment was left entirely to the therapists; they were encouraged to do what ever they felt would get the best results. The treatments were monitored by observers who used pre-established criteria to verify that the CTA therapists were not using a problem solving approach.

The measures used to assess skill acquisition were: the COPM[47] and the PQRS, adapted to a 10-point scale from Martini's[39] original 5-point scale. Measures of adaptive behaviour, handwriting, general motor proficiency, and self-esteem were used to evaluate generalization and transfer. The measures used were: the VABS,[48] the Evaluation Tool of Children's Handwriting (ETCH), the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP),[54] the VMI,[49] and the Self-Perception Profile for Children (SPPC),[55] respectively. All measures were administered pre and post treatment by an independent evaluator, blinded to group status, with one exception. The COPM, which, as indicated above, serves both as a component of the CO-OP approach and a pre-post measure, was administered by the treating therapist.

A series of two factor ANOVAs comparing the two treatment groups across pretest and post-test scores were used to analyze the data. Results indicated that both treatments lead to improved COPM self-ratings of performance and satisfaction. However, improvements in the CO-OP group were significantly greater than those in the CTA group. These results were paralleled by PQRS scores, and the Motor scores on the VABS, demonstrating that children in the CO-OP group were rated by independent observers and by standardized techniques to have improved significantly more than children in the CTA group.

In conclusion, self-report, blinded observer report, and standardized assessment results from an independent, blinded tester, all demonstrated the effectiveness of the CO-OP approach in this pilot study. This was a remarkable finding. The ability to detect significant group differences with a sample of only 10 children per group implies that the magnitude of the effect of CO-OP treatment was very large. Indeed, group differences found were in the order of one standard deviation and greater for the COPM and the PQRS, and approaching one standard deviation for the VABS domain scores. Effect sizes of this magnitude are rare, if not non-existent, in treatment studies with this population. The results of this study, in combination with the results of

the single case studies reported previously, provide strong support for the use of CO-OP with this population.

STUDY V: CLINICAL REPLICATION-CUMULATIVE EVIDENCE

CO-OP has now been used in the university clinic for approximately six years. Four therapists have been trained in the approach and have used it with 35 children for 105 performance goals that they identified as things they want to, need to, or were expected to do. The children all were between the ages of seven and twelve and attended the university clinic on evenings or weekends. At least one parent for each child was present for a minimum of four of the sessions.

As a matter of routine, unless the data are already available on the child's chart from elsewhere, the treating therapist does the intake assessments, to verify that the child meets the criteria for DCD and is appropriate for the CO-OP approach. The intake assessments include the Kaufman Brief Intelligence Test (K-BlT),[56] the Movement Assessment Battery for Children (M-ABC),[57] and the VMI.[49] The therapist also administers the COPM,[47] at the outset of treatment to establish the child's goals and then at the end of treatment to measure outcome. Where resources permit, an independent tester is used to administer outcome measures, pre and post treatment, to provide independent validation of goal attainment and address generalizability and transferability. The former is done by applying the PQRS[39] to videotaped sessions. The latter is done Using the survey form of the interview edition of the VABS.[48] From time to time these measures are changed, e.g., at times the M-ABC is used as a pre and post measure, while at other times (e.g., during the pilot RCT, see above) it is used only as an intake measure.

For Study V, the data from these measures were compiled in a retrospective chart audit of clinic records to determine the clinical replicability of CO-OP. Specifically, an analysis of data from a retrospective chart audit was completed to determine if the treatment effects reported in Studies I and II could be replicated in a clinic by different therapists working with different children with DCD.

The retrospective chart audit yielded data for 25 of 35 children (10 children were excluded from the analyses because of missing data). All 25 children met the criteria for DCD and many (40%) also had

other diagnoses, e.g., learning disabilities or attention deficit disorder. The measures for which data were available appear in Table 4, as do the sample sizes associated with each measure. As can be seen, typical of any retrospective chart audit, there were many missing data. This occurred for several reasons, some of which are alluded to above, i.e., feasibility, data on like measures available from other sources and studies requiring different measures. Using a within group design, the data were analyzed to determine pre/post test differences. Paired t-tests were carried out. The results (see Table 4) show that CO-OP positively affects direct skill acquisition. This can be seen in the significant improvement in the COPM scores on both performance and satisfaction. The results also indicate that the effects of CO-OP generalize and transfer. This can be seen in the significant improvement on the M-ABC in the areas of ball skills, balance and overall performance; on the VMI; and on the VABS in the areas of communication and motor performance and on the composite. Because of the relatively small overall sample size, the t-test analyses were performed without error rate control for multiple analyses. However, application of a Bonferroni adjustment* does not alter the interpretation of the analyses, indicating that, even in the context of a very conservative adjustment to the Type l error rate, several important effects are apparent. Most notably, the M-ABC Total Impairment Score, the VABS Composite Score, and the Performance and Satisfaction scores of the COPM all yield significant treatment effects.

When considered in combination with the relatively small sample size of some of the t-tests performed, the conservative treatment of significance levels, the effects are considerable. Thus, the results of Study V provide evidence of the clinical replicability of the treatment effect first observed in Study I.

DISCUSSION

The purpose of this paper was to present a summary of a series of studies carried out in the development and evaluation of a new treatment

*Given the number of t-tests performed, it is statistically possible that some of the effects found represent Type 1 errors. To control for this, a Bonferroni adjustment was made to the Type 1 error rate by dividing alpha across the 16 t-tests performed (a = .05/16 = .003). This adjustment yields a conservative interpretation of the t-test results.[58]

TABLE 4. Study V-Clinical Replication Outcomes

		N	Mean		SD		t	df	p value
			Pre	Post	Pre	Post			
COPM	Performance	25	3.49	8.32	1.56	1.35	11.68	24	< .001
	Satisfaction		3.59	9.21	1.72	0.83	14.07	24	<.001
M-ABC	Manual Dexterity[1]	14	7.39	6.68	4.46	3.93	0.97	13	.349
	Ball Skills		3.21	1.93	3.12	2.79	2.49	13	.027
	Balance		6.11	3.18	4.09	3.92	3.07	13	.009
	Total Impairment		16.71	11.78	8.94	8.78	3.95	13	.002
VMI		24	92.08	98.33	14.47	13.44	2.74	23	.012
VABS	Communication	15	88.87	97.80	13.95	13.95	3.02	14	.009
	Daily Living Skills		83.33	88.53	16.28	13.34	2.09	14	.055
	Socialization		86.13	90.73	15.25	13.39	1.86	14	.085
	Motor		87.47	100.20	19.88	16.26	2.94	14	.011
	Composite		83.20	90.13	13.85	14.58	4.16	14	.001

[1] The M-ABC yields an impairment score, a decrease in score therefore indicates improvement.

approach to DCD and to discuss the implications of the finding. The approach, CO-OP, is adapted from Meichenbaum's cognitive behavioural approach and thus represents a very different perspective on motor skill acquisition and the performance problems of children with DCD. In contrast to traditional views, CO-OP is based on the premise that motor performance is not primarily an issue of neuromaturation, rather an issue of learning and that children with DCD have a motor learning problem. The series of five studies presented here have each, in a systematic fashion, contributed to an evaluation of this basic premise and the development of a new treatment approach with demonstrated effectiveness.

The potential of a learning model to guide the skill acquisition of children with a mild motor impairment was first demonstrated in the series of single case experiments of Study I. Those findings indicated that strategy use, by itself, could enable a child with DCD to perform a difficult motor based activity, competently. This suggests that the performance issue is less likely a neuromaturational one and more likely one of learning. However, as Ottenbacher[38] pointed out, showing an effect at one time, with one therapist, is insufficient evidence to establish the efficacy of an approach. ''The ultimate test of generalizability for any treatment finding is whether other therapists can implement the intervention procedure under other situational conditions with other clients and achieve similar outcomes'' (p. 207).

Studies II, IV and V addressed the generalizability by demonstrating that the effect was reproducible across therapists, children and a large variety of activities. Study IV also showed that the approach was more effective than the current approach being used by experienced therapists. This not only satisfied Ottenbacher's third phase of generalizability, showing clinical replication of the treatment effect, it also provided evidence of the effect of CO-OP as compared to current treatment practices. Studies IV and V, together showed that the effect was not restricted to the skills directly considered in the course of treatment but also generalized and transferred to other related skills. Taken together these studies provide strong convergent evidence that CO-OP is an effective approach for use with children with DCD.

The outcome of this series of studies is not only a new treatment approach but also new insights into DCD and motor acquisition. Children with DCD comprise a significant proportion of school-aged children and studies have provided evidence suggesting that the long-term effects of this disorder are handicapping for these children. The pro-

gram of research described here has identified a treatment approach that intervenes at the level of disability to improve performance in daily occupations. The approach in no way attempts to 'cure' DCD. There is, at present, no evidence that the impairment of motor coordination in these children can be cured. Indeed the success of this approach, embedded in a learning paradigm, in enabling children with DCD to use strategies to effect a change in performance, would suggest that this is not a problem in search of a cure. Rather, it is a problem in search of effective learning strategies that will enable the children to perform the activities they need to, want to, or are required to perform.

Consistent with the present health care trend of client-centred practice and consumer satisfaction, the CO-OP treatment approach actively involves the family. The approach is both cost effective, as evidenced by maintenance of acquired skills, and portable. CO-OP is a child-centred, cognitive based intervention, focused on enabling children to achieve their functional goals. It was developed to help children with DCD acquire functional skills that they find difficult to perform. CO-OP intervention is individually tailored and highly responsive to each child. The CO-OP approach builds upon the child's strengths and enables the child to improve his/her performance on self-selected activities. There is evidence that CO-OP is effective in enabling skill acquisition and there is growing indication that CO-OP also results in generalization and transfer of skills. The next step would be to evaluate the effectiveness of CO-OP when administered within the school setting, as opposed to the clinic setting.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the important contributions of four groups to this work. First, we wish to express our gratitude to the three graduate students who devoted their thesis work to this endeavor. Anne Wilcox was visionary enough to take an idea and translate it into action. She pioneered the successful application of cognitive strategies to skill acquisition among children with mild motor problems. Rose Martini was courageous enough to hold herself up as the therapist who would replicate the results. She undertook to master this new technique and carry out a systematic replication. In doing so, she not only demonstrated that further development of the approach was warranted, but also how the approach could be taught to other therapists. Angie Mandich was insightful enough to question the assertions about the potency of the global strategy and searched for evidence of other strategy use. Angie's data provided evidence that the global strategy was a necessary compo-

nent of the approach but not sufficient; that other strategies, specifically, domain specific strategies were important to skill acquisition. Second, our appreciation goes to the therapists who were willing to come to work in our research clinic to learn the approach: Katherine Harris, Becky Lawson, Leala Lee, Penny Letheren, and Viola Sternberger. Their thoughtful participation contributed to the refinement and elucidation of the key features of the approach. Third, we wish to acknowledge the contributions of the many children and their families who participated. We are truly indebted to them for raising the issues and guiding us in the discovery of a solution. Finally, we wish to thank our funders, the Hospital for Sick Children Foundation for funding the pilot RCT and the Cloverleaf Charitable Foundation which has been with us almost from the outset. Their continued interest in our work and their ongoing financial support have made this work possible.

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