Research in Developmental Disabilities xxx (2010) xxx–xxx

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Cognitive modifiability of children with developmental disabilities: A multicentre study using Feuerstein's Instrumental Enrichment—Basic program

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A R T I C L E I N F O

Article history:
Received 2 October 2009
Received in revised form 11 November 2009
Accepted 1 December 2009

Keywords:
Children with developmental disabilities
Cognitive education
Cognitive modifiability
Feuerstein Instrumental Enrichment Program
Mediated learning experience

A B S T R A C T

The study aimed at exploring the effectiveness of cognitive intervention with the new "Instrumental Enrichment Basic" program (IE-basic), based on Feuerstein's theory of structural cognitive modifiability that contends that a child's cognitive functioning can be significantly modified through mediated learning intervention. The IE-basic progam is aimed at enhancing domain-general cognitive functioning in a number of areas (systematic perception, self-regulation abilities, conceptual vocabulary, planning, decoding emotions and social relations) as well as transferring learnt principles to daily life domains. Participants were children with DCD, CP, intellectual impairment of genetic origin, autistic spectrum disorder, ADHD or other learning disorders, with a mental age of 5–7 years, from Canada, Chile, Belgium, Italy and Israel. Children in the experimental groups ($N = 104$) received 27–90 h of the program during 30–45 weeks; the comparison groups ($N = 72$) received general occupational and sensory–motor therapy. Analysis of the pre- to post-test gain scores demonstrated significant ($p < 0.05$) advantage of experimental over comparison groups in three WISC-R subtests ("Similarities", "Picture Completion", "Picture Arrangement") and Raven Coloured Matrices. Effect sizes ranged from 0.3 to 0.52. Results suggest that it is possible to improve cognitive functioning of children with developmental disability. No advantage was found for children with specific aetiology. Greater cognitive gains were demonstrated by children who received the program in an educational context where all teachers were committed to the principles of mediated learning.

1. Introduction

1.1. Feuerstein's theory and applications of structural cognitive modifiability and mediated learning experience

Feuerstein, Rand, Hoffman, and Miller (1980) stipulate in their theories of Structural Cognitive Modifiability and Mediated Learning Experience (MLE) that a child's cognitive performance can be significantly modified through mediated

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doi:10.1016/j.ridd.2009.12.001

learning intervention aimed at creating new cognitive structures. Together with Vygotsky, Bruner and Bronfenbrenner, Feuerstein's theory can be regarded as fitting in the ecological and cultural constructivist model of intelligence, which stresses the social and cultural origin of cognitive development. Though having in common many basic concepts with the cognitive structuralist theories of Piaget (Kozulin, 1998), Feuerstein et al. qualified mediating intervention as a specific human intervention which is different from just stimulating a child. In a mediating intervention, the mediator – a parent, caregiver, teacher, therapist, older child, anyone with a specific intention – interposes himself between the world of stimuli and the child, in order that the child will assimilate the stimuli into internalized cognitive structures, so as to become modified by them. To that purpose, the mediator adapts stimuli by selecting, filtering, magnifying, or reducing, naming, relating them to other stimuli, etc. Stimuli are the normal stimuli of a child's world, objects, events, actions, smiles, anything. The difference with "normal" pedagogical interactions is that an MLE interaction responds to 12 criteria. An interaction becomes a mediating interaction when there is at least an explicit intentionality on the part of the mediator, with the child reciprocating that intention; an attempt to "transcend" the here-and-now, relate to other situations, to add a meaning to the stimulus, to regulate behaviour, to boost feelings of competence.

A child's cognitive modifiability depends on the MLE acquired by the child in interaction with mediating caregivers. MLE plays a moderating role as a proximal factor of the child's development, so that children with a similar aetiology demonstrate different developmental outcomes depending on the amount and quality of their MLE (Feuerstein & Rand, 1974).

This general hypothesis has been tested with different populations, ranging from young children with low birth weight (Klein, Wieder, & Greenspan, 1987) to adolescents with intellectual disability with various aetiologies (Arbitman-Smith, Haywood, & Bransford, 1984). Children who have received an insufficient amount or type of MLE demonstrate reduced cognitive modifiability. This condition, however, can be changed through therapeutic intervention loaded with mediation and based on the specially designed cognitive enrichment program "Instrumental Enrichment" (IE) (Feuerstein et al., 1980). The IE program includes several units of paper and pencil tasks aimed at cognitive areas such as analytic perception, comparison, classification, orientation in space and time, etc. The program is attuned predominantly to the needs of nine-year-old children and older. The impact of IE has been researched extensively in different countries with populations of children and young adults ranging from regular to learning disabled, with intellectual disability or neurological impairment (Kozulin, 2000; Romney & Samuels, 2001).

A general theoretical background and certain methodological aspects of IE have been used in the design of a new cognitive intervention program called "Instrumental Enrichment Basic" (IE-B) aimed at younger children (aged 5–7) and older children with serious cognitive deficiencies (Feuerstein & Feuerstein, 2003). The program covers four major cognitive areas: 1. Perceptual–motor development, oriented toward visuo-motor coordination, attention and planning behaviour (*Organization of Dots-B*, *Tri-Channel Attentional Learning*; Spatial orientation (*Orientation in Space-B*); 2. Decoding emotional expression and understanding their social/behavioural correlates (*Identifying Emotions*; *From Empathy to Action*); 3. Abstractive/integrative thinking (*From Unit to Group*; *Knowledge*; *Compare and Discover the Absurd*; *Thinking to Learn to Prevent Violence*; *Learning to Question for Reading Comprehension*).

The IE-B materials have been tested in a pilot version by their authors with a number of regular and learning disabled children. An IE-B Manual for professionals has been written and a model for professional training in IE-B developed and implemented. The present study is the first attempt to explore the effectiveness of IE-B program with children who have cognitive problems associated with genetic or neurological impairments.

1.2. Cognitive modifiability of children with developmental disability

Considerable advances have been made in terms of educational philosophy, policy, and curriculum development in the direction of creating conditions for effective inclusion of children with developmental disabilities. A large number of research studies were conducted in order to determine the optimal form of teaching reading and mathematics. Relatively little attention has been paid to the cognitive development of children with developmental disabilities, such as cerebral palsy, Down syndrome and other genetic syndromes, and intellectual impairment. Research on the impact of cognitive enrichment programs on younger children with serious cognitive and learning problems is rather limited.

Young children with intellectual impairment are capable of participating in and benefiting from cognitive enrichment programs. Klauer's (2002) inductive reasoning program and Paour's (1993) "transformation box" program have been shown to advance children with intellectual impairment beyond the pre-operational level of thinking. Brooks and Haywood (2003) demonstrated a significant increase in children's self-regulation functions, role taking, learning of number and letter/shape concepts, as well as comparison, classification and patterns, with the "Bright Start" program, whose didactic principles are also based on the Feuerstein et al. (1980) concept of mediated learning experience. A group of children with intellectual impairment showed a rise of 12.15 IQ points, corresponding to the effect size of 0.81, while a group of "at risk" children gained 8.92 IQ points. "At risk" children who received non-cognitive enrichment activities gained only 1.09 IQ points (Haywood, Brooks, & Burns, 1986). Samuels, Killip, MacKenzie, & Fagan (1992) showed that a 1 year application of Bright Start with children with severe learning disabilities allowed 75% of the intervention group to be recommended for regular classes versus only 25% of the non-cognitive control group.

Cognitive development in children with intellectual impairment has a different age dynamics. Gunn and Jarrold (2004) showed that in 9–18 year old children with Down syndrome, the correlation between chronological age and task

Please cite this article in press as: Kozulin, A., et al. Cognitive modifiability of children with developmental disabilities: A multicentre study using Feuerstein's Instrumental Enrichment—Basic program. *Research in Developmental Disabilities* (2010), doi:10.1016/j.ridd.2009.12.001

performance was much weaker ($r = 0.34$) than in typically developing 4–10 year olds ($r = 0.71$). In children with Fragile X syndrome, an age related decline in cognitive performance has been reported (Fisch et al., 1999).

While acknowledging the benefits of the above mentioned programmes, the IE-basic program adds more structured opportunities for cognitive enrichment in the social/emotional area, as well as in visual–motor coordination and therefore was worthwhile trying out in a population which is particularly deficient in these areas. It has been shown that children diagnosed with autistic spectrum disorder (ASD) and developmental coordination disorder (DCD) have difficulties in executive cognitive functions, which underly difficulties in social behaviour or praxic functions such as drawing, reading and writing. In view of the increasing prevalence of children diagnosed with ASD or DCD, it would be important to offer therapeutic opportunities which address these particular cognitive functions. There have been applications with regular Instrumental Enrichment with school aged children with DCD and ASD which have shown a potentially positive effect on cognitive as well as behaviour functioning (Schnitzer, Andries, & Lebeer, 2007). The IE program seems to be promising in this respect.

1.3. Study objectives

The study aimed at exploring the effectiveness, validity and optimal conditions of cognitive intervention with the new ''Instrumental Enrichment Basic'' program (IE-B) in enhancing cognitive functioning of children with developmental disabilities and cognitive impairments.

2. Participants and methods

2.1. Participants

The study was conducted in 5 countries (Italy, Israel, Belgium, Chile, and Canada) with a total of 188 children. Inclusion criteria were: children with an identified neurological developmental disturbance (DCD, CP, intellectual impairment of genetic origin, autistic spectrum disorder, ADHD) with a mental age 5–7; mean chronological age 106.93 months (49–243 months, SD = 36.26). Table 1 shows the distribution of children by country and by diagnostic group.

Within each participating country, children with a mental age of 5–7 were identified on the basis of school psychologists' records. In all the cases the IE-B program was given as a part of the children's ongoing educational or treatment process. Parents and the schools and/or institution where the children were learning were informed of the content of the IE-B program and consented to participation in the study. Children were then assigned to experimental (IE-B) or comparison intervention programs. At some research sites such as Milan, Italy and Israel where intervention was carried out individually, it was possible to assign children to the experimental and comparison intervention randomly. At other sites (e.g. Chile, Belgium) pre-existent groups of students were used and so experimental or comparative intervention was given to a group as a whole. This prevented equalizing the pre-test performance level of experimental and control groups.

2.2. Outcome measures

All participants were individually pre- and post-tested using five sub-tests of WISC-R (''Similarities'', ''Arithmetic'', ''Picture Completion'', ''Picture Arrangement'', and ''Block Design''), and Raven Coloured Matrices. Pre-tests were taken in a period of 4 weeks before the start of the intervention. Because of the young age and low performance some children were pre-tested using the corresponding WPPSI tests. These cases will be discussed separately. For some children who had received a WISC or WPPSI 6 months prior to the intervention, the pretest results were taken from the files and only the Raven's matrices were administered anew.

As application of the IE-B program involves a combination of paper-and-pencil tools and mediation, the quality of teachers/therapists mediation was assessed by observing video fragments of each mediator, using Lidz's (1991) mediation evaluation scale, so as to calibrate each of the teachers involved. In addition, all teachers/therapists were asked to keep a ''diary'' so that the process of learning in each group could be gauged.

Table 1
Distribution of children by country and diagnostic category.

	Canada	Chile	Belgium	Italy	Israel	Totals
Down syndrome	1	27	2	8	13	51
Other genetic intellectual disorders		1	1	10		12
Non-genetic intellectual disorders	11	22	6			39
Autistic Spectrum Disorder	4	1	6			11
Cerebral Palsy		1	3	9		13
Developmental Coordination Disorder			8	14	23	45
ADHD			2			2
Other (learning disabilities, language delay, etc.)	6		9			15
Totals	22	52	37	41	36	188

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The pre–post-test measures were intersparced by at least 12 months and included the (national language) WISC-R and Raven's Coloured Progressive Matrices (CPM) (Raven & Raven, 2003). They cover the main areas of cognitive changes that are most salient in the study (Sattler, 2002). Raw scores were used in the data analysis. In all DCD cases the assessors were "blind" to the placement of children. Due to organisational reasons, however, it was impossible to ensure that in other cases all testers were blind as to the belonging to experimental or control groups.

2.3. Intervention program

Children in the majority of experimental groups received IE-B sessions for a period of 30–45 weeks, for a total of 90 h. One group in Israel received only 27 h of intervention for a period of 27 weeks. Children in the comparison groups received an equal number of hours of occupational therapy, sensory–motor training or curricular studies.

IE-Basic instruments used in the present research included: Organization of Dots; From Unit to Group; Orientation in Space; Compare and Discover the Absurd; Identifying Emotions, From Empathy to Action.

Organization of Dots-Basic is aimed at developing children's cognitive functions in a figural and visual–motor modality. The child is mediated to identify a geometric shape presented as a model in an amorphous cloud of dots. The child learns to overcome difficulties caused by the rotation of the figures and the proximity of the dots. The instrument promotes analytic perception of shapes, conservation of form and size, planning, need for precision and restraint of impulsivity.

From Unit to Group helps children to establish the concept of number and the basic mathematical operations by discovering the way in which objects can be aggregated, segregated, summarized and described. The tasks include counting and grouping simple visual stimuli such as dots, triangles, circles, squares, etc. The instrument promotes systematic exploration of data, systematic following of rules, and consideration of several sources of information, comparison, categorization, inferential thinking and deductive reasoning.

Orientation in Space-Basic is aimed at developing spatial concepts and orientation in two-dimensional pictorial space representing everyday life situations. This requires scanning the pictorial information, identifying the relative position of objects and events, and the development of a conceptual vocabulary. The tasks include responding to verbal instructions.

Identifying Emotions develops the children's ability to decode behavioural and social cues that signify emotional states. At the top of each page there is a stimulus photograph showing certain emotional states and four pictures showing different life situations. Children are first mediated to look at the top photograph and label the emotion, and then to analyze each one of the "stories" depicted in four illustrations in terms of relevant emotional states of the characters involved.

Compare and Discover the Absurd uses absurd or incongruous situations in a cartoon modality in order to develop the children's ability to use selected criteria as a basis for comparison and to develop a system of sub- and super-ordinate concepts. Both more basic (size, shape, direction, quantity) as well as more complex (age, function) criteria are used. The instrument is aimed at developing higher cognitive functions, expressive language, and coordination of pictorial analysis with verbal responses.

In every lesson, the mediator introduces a page of the instrument, asks the children what they see, whether they know what to do; explains the task; then mediates towards succesful completion of the task by asking questions, giving vocabulary, focussing and searching important information, orienating the child, inducing hypothetical thinking, comparing parts of the page, explaining concepts and referring to the real world. Regulation of behaviour is used prior and during task resolution. A lesson typically lasts 3/4 to 1.5 h, depending on attention span. The aim is each time to increase attention span.

3. Results

Table 2 shows the pre to post-program cognitive gains as shown in WISC-R and Raven Matrices tests. Some children from the Belgian group and the Italian group were excluded from this table because they were pre-tested using WPPSI, rather than WISC-R. Because the Canadian group used the "Picture Concept" from the later version of WISC, rather than "Picture Arrangement" WISC-R subtest the data regarding this test has been omitted.

After Levene's test for equality of variances was performed, *t*-tests were conducted assuming equal or unequal variances where appropriate. All subtest gains in the experimental groups were greater than in comparison groups; the difference

Table 2
Average pre-and post-test results and gain scores of experimental and comparison groups.

	Experimental $N = 95$			Comparison $N = 49$		
	Pre	Post	Gain	Pre	Post	Gain
"Similarity"	5.83 (5.14)	8.26 (6.69)	2.38 (3.69)*	4.86 (4.50)	5.82 (4.83)	1.04 (2.19)
"Arithmetic"	5.44 (4.29)	6.76 (5.06)	1.22 (2.25)	4.94 (3.09)	5.76 (3.06)	.98 (1.94)
"Picture completion"	6.79 (6.79)	9.15 (8.09)	2.29 (3.85)*	4.98 (5.14)	5.82 (5.88)	.71 (2.42)
"Block design"	8.12 (10.48)	10.90 (13.07)	2.65 (5.33)	4.59 (5.86)	6.65 (8.86)	1.96 (4.39)
Raven Matrices	14.04 (8.63)	17.29 (8.23)	3.16 (5.59)*	12.07 (6.62)	13.37 (7.64)	1.30 (3.88)

Standard deviations in parenthesis *$p < 0.05$.

Table 3
Gain scores of Canada's experimental vs. other experimental groups.

	Canada ($N = 21$)	Other ($N = 79$)
"Similarity"	4.57 (4.42)*	1.39 (2.57)
"Arithmetic"	2.62 (3.03)*	0.52 (1.16)
"Picture completion"	5.81 (4.54)*	0.32 (2.23)
"Block design"	6.52 (4.29)*	1.30 (3.12)
Raven Matrices	5.57 (4.29)*	1.89 (4.19)

Standard deviations in parenthesis (*$p < 0.05$).

Table 4
Gain scores in the Jerusalem sample of children with Down Syndrome vs. children with Down syndrome from other experimental groups.

	DS Jerusalem ($N = 13$)	DS other groups ($N = 33$)
"Similarity"	0.77 (2.92)	1.24 (2.11)
"Arithmetic"	0.77 (1.88)	0.30 (0.88)
"Picture completion"	3.23 (4.36)*	0.15 (2.14)
"Block design"	1.23 (6.51)	0.27 (1.72)
Raven Matrices	6.92 (6.98)*	1.28 (3.04)

Standard deviations in parenthesis (*$p < 0.05$).

reached a statistically significant level in "Similarities" ($t = 2.69$; $p = .008$), "Picture Completion" ($t = 2.98$; $p = .003$) and Raven Matrices ($t = 2.38$; $p = .019$).

While, predictably, children with DCD had higher scores both at the pre- as well as post-tests, there were no statistically significant differences between gains made in experimental and comparison groups by either children with Down syndrome or DCD.

Additional research question concerns the possible difference between the contexts in which the IE-B program was implemented. The main finding here is that after controlling for diagnosis, the experimental group in Canada made significantly greater gains than other experimental groups in all the WISC-R subtests and Raven Matrices (see Table 3). Children of the Canadian sample were somewhat older than those in other groups and their pre-test scores were higher. However, even after controlling for the age, the gain scores of the Canada sample remained statistically higher in all sub-tests except "Block Design" (where it was close to being significant $p = 0.072$). Moreover, the comparison of Canadian sample with a sample from other experimental groups matched for both age and pre-test performance level, demonstrated significant advantage of Canadian sample in the gain scores ($t = 4.58$, $p = 0.000$, for Raven Matrices). The implementation of the program in Canada was made in the context of a special school totally committed to philosophy and practice of mediated learning. This means that children of the Canadian sample received a greater amount of mediation than children in other groups, though they received exactly the same number of IE-Basic program hours.

Difference in gain scores was observed also between younger children with Down syndrome from an experimental group in Jerusalem and other children with the same diagnosis (see Table 4). Children in the Jerusalem group made significantly

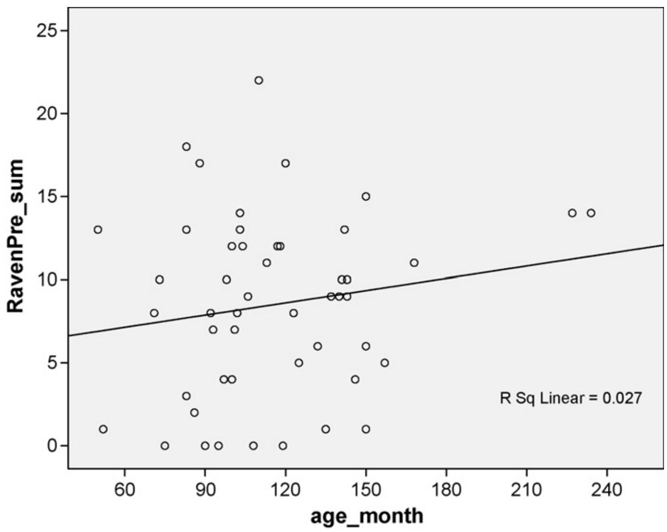

Fig. 1. Cross-sectional data on age-related trends in Raven Coloured Matrices performance of children with Down syndrome.

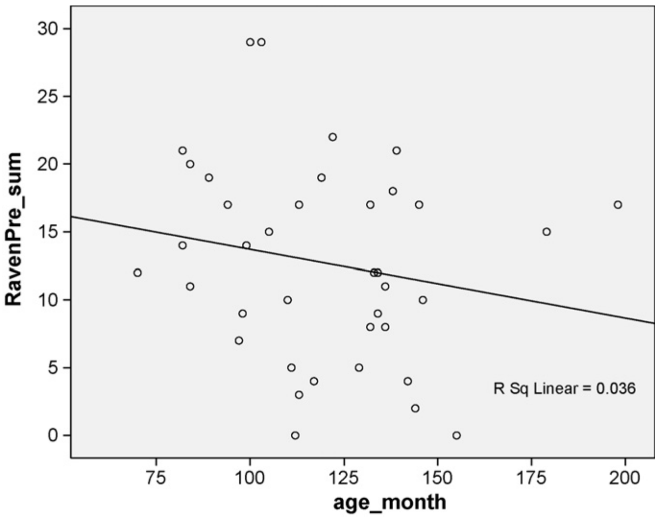

Fig. 2. Cross-sectional data on age-related trends in Raven Coloured Matrices performance of children with non-genetic intellectual disabilities.

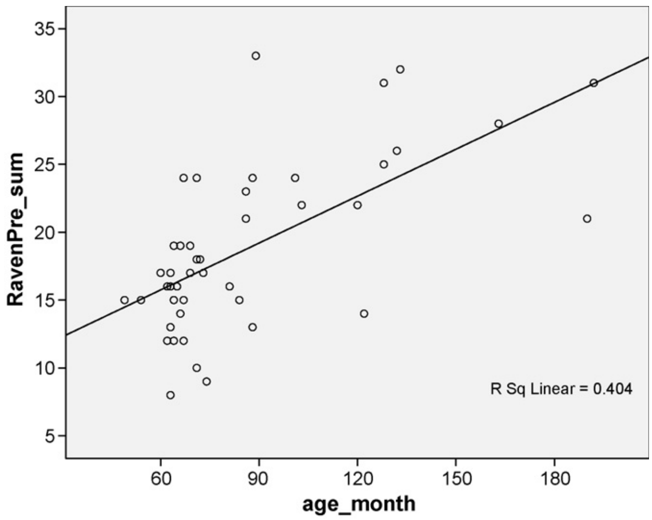

Fig. 3. Cross-sectional data on age-related trends in Raven Coloured Matrices performance of children with DCD.

greater gains in the "Picture completion" subtest and the Raven Matrices test, though they were significantly younger than children with DS from other research sites (89 months vs. 117 months; $t = 4.83$; $p = .000$). Moreover, their Raven Matrices post-test results were significantly higher than those of older children with DS in other experimental groups ($M = 13.54$ SD = 5.52 vs. $M = 9.89$ SD = 4.78; $t = 2.27$, $p = 0.028$).

Finally, it seemed important to use the accumulated data in order to project developmental trends in children belonging to different diagnostic groups. Such trends might be indispensable for predicting the impact of any intervention program on the children's cognitive performance. While data on children with regular developmental history are usually included in test manuals (Raven and Raven, 2003; Wechsler, 1974), in the case of children with developmental disabilities the situation is more complicated and the developmental trends should be established for each diagnostic group separately. Figs. 1–3 show cross-sectional data for children with DS, non-genetic intellectual disability and DCD based on their pre-test Raven Coloured Matrices performance. One can see that while there is a reasonably good age-related change in the performance of DCD children, this is not a case for children with Down syndrome or non-genetic intellectual disabilities. For example, the performance of an older child, an 11 year old is often at the same level as a younger, 8 year old one.

4. Discussion

The present study constitutes the first attempt to evaluate the effectiveness of a new cognitive intervention program (IE-Basic) and as such it has a number of limitations. Some of these are related to the nature of target populations of children with serious cognitive and learning problems. For example, the extreme heterogeneity of children's performance level and the lack of age-related developmental trends characteristic of typically developing children and the low numbers per diagnostic category, make the use of group statistical methods problematic. Certain difficulties were also encountered in selecting the appropriate comparison groups. For example, no adequate match could be found for an experimental group in Canada because no other educational institution had its entire staff trained in a specific intervention philosophy. Therefore, this makes it difficult to make strong conclusions about the effect of the program per se. Nevertheless the findings bear some relevance to the important question of modifiability in the case of developmental disability.

As mentioned in the literature review section, cognitive enhancement of children with severe cognitive and learning problems seems to receive inadequately little attention at an age when the declared goal of practically every educational system is to prepare these children for inclusive education. The proliferation of studies on the development of basic skills, such as reading and mathematics in children with learning disabilities seems to overshadow the need to attend to the problems of children with more severe cognitive difficulties. We do not believe that inclusive education would succeed if children with developmental disabilities were just placed physically into normative classrooms. We also doubt the success in teaching them curricular subjects without simultaneously enriching their cognitive skills. A certain level of cognitive performance constitutes, in our opinion, the necessary pre-requisite for successful curricular learning. At the same time the proper combination of cognitive enhancement activities and curricular studies should result in significant advancement of both cognitive and domain specific skills of special needs children. The above task is daunting taking into account that the cognitive development of children, who have difficulties associated for example with Down syndrome, is far from being spontaneous. In other words it is not only that children with developmental disability demonstrate lower cognitive performance results, but they also demonstrate much slower age-related change (see Figs. 1–3). This makes the issue of cognitive enrichment activities for these children crucial.

The first conclusion that can be drawn from the present study is that the IE-basic is a valid program to enhance general cognitive functioning in children with learning disability and a mild to moderate intellectual impairment. Even children with a very low initial performance level are capable of participating in and benefiting from the IE-Basic program. As could be expected, the greater change occurred in performance with those tasks that require fluid intelligence, such as Raven Coloured Matrices. Performance with the tasks that require domain-specific crystallized intelligence such as "Arithmetic" was less affected by IE-B cognitive intervention. It seems remarkable that a child who at the pre-test was unable to solve any Raven Coloured Matrices tasks, correctly solved 50% of the tasks at the post-test. This and similar results confirm that even children with very low initial performance level may demonstrate remarkable modifiability and after appropriate cognitive intervention arrive at much higher cognitive performance. At the same time, the modifiability apparently is not global but rather modular. Significant change in non-verbal reasoning may occur simultaneously with little or no progress in verbal functions or operations that require content knowledge such as in the "Arithmetic" sub-test.

The second conclusion is that in the fluid intelligence tasks the IE-Basic groups made significantly greater gains than comparison groups (see Table 2). This indicates that IE-Basic has a certain potential over other intervention programs in enhancing generalized cognitive modifiability. But further research is needed, with longitudinal intervention allowing to study age-related effects, with larger groups per diagnostic category and also specifically looking at academic achievement. Although qualitative analysis of recorded sessions and teachers' reports suggested that the IE-basic program is also valid in enhancing executive functioning problems, self-regulation difficulties, visuo-motor coordination as well as social–emotional recognition skills, this needs further research in more homogenous groups with appropriate evaluation tools.

The effect sizes were not large, primarily because of the large standard deviations. Even in the same diagnostic group, like Down syndrome, a wide range of performance was observed both at the pre- and the post-tests. An attempt to find out whether one of the larger diagnostic groups such as Down syndrome and DCD is particularly sensitive to IE-Basic intervention was not successful. In both diagnostic groups the difference between gains in experimental and comparison groups was non-significant. This indicates that the ability to benefit from the IE-Basic program is related to individual learning profiles of the child and the context of program application, including the mediation qualities of the teachers, rather than diagnostic category.

The question remains – as with all types of intervention progammes – what really constitutes the intervention in contributing to the cognitive improvement of the children: is it the program as such, or is it the teacher using the materials, i.e. the "mediation quality" of the teacher – as defined by Feuerstein's MLE criteria? It might be conceivable that the teachers in the experimental group obtained more results, because they dialogue more, focus more, are more enthusiastic and persistent in obtaining a child's response and perhaps other ways to teach concepts and behaviours. There was no significant difference in the mediation quality of the teachers between the experimental groups, but the research design was not able to differentiate between meditational qualities of teachers of experimental and control groups. But even if the mediation quality of the teacher would be the most important element, more than the program, that finding is in itself important because the goal is to enable the child's modifiability and learning processes. The Instrumental Enrichment program, as its name says, is meant to be instrumental; its instruction manuals explicitly state the importance of mediation in applying the work. This is the reason why the program is not available in the public market but only after sufficient training. Clearly, mediated intervention is not standardized, but a skill. The program cannot be applied "in a medical way" as in pharmaceutical intervention. Therefore a classic RCT study model may not be appliccable in this case and quantitative data need to be interpreted with caution.

It can be questioned whether the chosen test procedures to evaluate progress are the most suitable for this population. Although there may be better ways to study fluid intelligence, we chose subtests of the WISC and Raven, because they are widely used, standardized and recognized. While their usefulness to compare intellectual performance within the general population is well established, it is much less evident that they give a fair picture of intelligence in children performing in the lower area (Saklofske, Weiss, Beal, & Coalson, 2003). The Italian group of children who participated in this research, for example, contained proportionally more lower-functioning children. Generally in these cases the learning curve presents a degenerative trend with progressing age. In addition, in several tasks of the WISC R, from one year to another, the level of difficulty of the tasks increases. Therefore, zero gain scores might represent a real improvement. In one of the research sites (BE) it was observed that some children of the intervention group even performed worse on the post-test Raven's matrices than children in the comparison groups. This might be due to an observation made by one of the mediators, that some of the children of the intervention group, who became less impulsive, took more time to think. It might have to do with the fact that the tester in pre- and post-tests were different. Normally, given the standardized nature of the WISC and Raven, this should not have mattered. The static nature of psychometric tests, however, has been known to disadvantage students with special educational needs, who are highly influenced by the context and person doing the testing. A dynamic, interactive application of testing progress therefore might be able to better demonstrate progress (Lebeer, 2005; Sternberg & Grigorenko, 2002). In further studies it may be more relevant, rather than studying effect on fluid inteligence, to study effect of MLE on modifiability of executive functions, on behaviour, on social insight, on transfer to academic skills, on task learning.

The implementation format in this research seemed to have an importance. The comparison between gains made by children at different research sites indicated that program implementation in one of the research sites had a certain advantage over other sites (see Table 4). After controlling for age, diagnosis and pre-test performance level, children in the Canadian sample demonstrated higher gain scores than at other sites. The Canadian site was the only site where the entire educational process was based on the principles of Mediated Learning Experience. At other sites the IE-Basic program was given either as a clinical intervention separated both geographically and conceptually from the child's primary educational setting, or as an element of the child's main educational activity but without other teachers being exposed to MLE philosophy and practice. It seems that children in the Canadian experimental group had a greater chance to consolidate learning strategies and skills acquired during IE-Basic sessions because the same strategies "reappeared" in other lessons taught by teachers for whom cognitive development of children constitutes an integral element of curricular instruction. This points to the need to organize intervention in a systemic, ecological way, addressing the child's whole educational environment, teachers and whole program. More "ecological"studies should be able to study the conditions of modifiability of children with developmental disabilities, as was already evoked by Bronfenbrenner (1981).

A somewhat similar phenomenon was observed by Diamond, Barnett, Thomas, and Munro (2007) in the application of cognitive program "Tools for Mind" with pre-school children who lacked executive functions skills. As long as "Tools for Mind" was applied as an addition to regular curriculum, the effect of the program on students' executive functions was minimal, but it became significant after the entire learning process had been was reshaped along the Vygotskian approach embodied in "Tools for Mind".

5. Conclusion

The present research suggests that it is possible to significantly improve fluid intelligence in children with cognitive impairments, using a comprehensive program such as the Feuerstein Instrumental Enrichment, based on mediated learning experience. The above does not constitute a plea to a return to separate, specialized settings as opposed to more inclusive settings. It is an indication that the effectiveness of cognitive intervention depends on its comprehensive character and the commitment of all teachers or/and therapists to the same approach.

Acknowledgements

The present research was made possible through a financial support by the Mariani Foundation for Neuropediatrics, Milan, Italy. The authors would like to thank Dr. Maria Majno, director of the Mariani Foundation, for her continuing encouragement to pursue the research goals. They also would like to thank the program authors Reuven and Rafi S. Feuerstein for their theoretical insights and support. Furthermore they are particularly grateful to their co-researchers & therapists: Ann Neetens, Dany de Vooght & Katrien Bellefroid (Belgium); Alejandra Morales, Rita Arévalo, Chetty Espinoza & Cecilia Assél (Chile); Cristina Dornini & Daniela Costanzo (Italy); Marina Gonigberg, Susan Wagner, Yaya De Andrade & Kathleen Jeffrey (Canada); Niza Gavan, Monica Paz & Sari Alony (Israel); the families and children of the participating schools.

None of the researchers, nor the sponsor, has any commercial interest in the program utilized.

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Please cite this article in press as: Kozulin, A., et al. Cognitive modifiability of children with developmental disabilities: A multicentre study using Feuerstein's Instrumental Enrichment—Basic program. *Research in Developmental Disabilities* (2010), doi:10.1016/j.ridd.2009.12.001