Clinical and educational applications of Reuven Feuerstein's Mediated Learning Experience Theory: current scientific evidence

On April 29th 2014 Reuven Feuerstein passed away. Born in 1921 in Botosan (Romania), he spent most of his adult life in Israel, where he became the psychologist of Youth Alliah. After having studied with Jean Piaget in Geneva and finishing his PhD at the University La Sorbonne in Paris, he also became professor at Bar Ilan University near Tel Aviv. Through his experiences with deprived children in the refugee camps after World War II, he developed his theory of Mediated Learning Experience and Structural Cognitive Modifiability, and their applied systems of Instrumental Enrichment Programme (a cognitive-mediational intervention programme), Learning Propensity Assessment (a battery of dynamic assessment of modifiability) and a system-oriented approach of "active modifying environments". In the early sixties he founded the Hadassah-Wizo-Canada Research Institute in Jerusalem, later renamed into "International Centre for the Enhancement of Learning Potential", now "the Feuerstein Institute".
Reuven Feuerstein was in the first place a psychologist who was very committed to help disadvantaged children and adults, to go beyond their actual functional status and to escape from a self- or others-defined status of passive acceptance that "nothing can be done". But he also had a never-ending endeavour to look for a scientifically grounded theory.

Feuerstein, whom past-APA president Robert Sternberg called "one of the greatest 20th-century psychologists next to Piaget and Vygotsky", left an important intellectual heritage, which is a challenge for the world of today's problems. The Transylvanian Journal of Psychology (TSJP), a peer-reviewed international journal published by the Department of Applied Psychology of the Babes-Bolyai University in Cluj-Napoca, wanted to contribute to the preservation of this heritage by dedicating a two-volume Special Issue about the relevance of Feuerstein's ideas for the science of psychology as well as for its many applications in education, special needs education, clinical and medical psychology, neuropsychological rehabilitation and other domains.

In this N°1 volume, a number of invited scholars who have known him and worked with him (such as David Tzuriel, Robert Sternberg, Carl Haywood, Carol Lidz, Noami Hadas-Lidor, Hefziba Lifshitz, Jo Lebeer and David Martin), present reviews on the scientific evidence of Feuerstein's MLE and SCM theory, as well as on educational and clinical applications. After an open call, it also contains two contributions of young PhD researchers presenting parts of their original empirical research, in order to show that the next generation carries on with the work Feuerstein has initiated.

Education and Culture DG
Lifelong Learning Programme

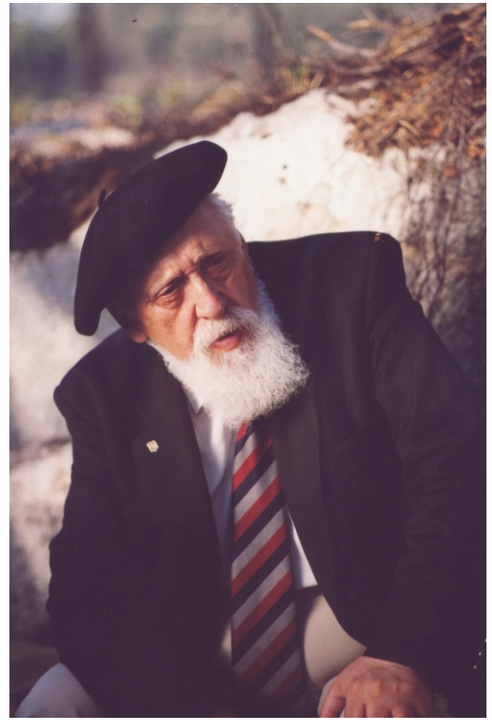
enablin+
Enabling & Including Young People with Complex & Intense Support Needs

Disclaimer. This project has been funded with support from the European Commission, Life Long Learning Programme. Contract 541981-LLP-1-2013-1-BE-LEONARDO-LMP.This document reflects the views of the authors only, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

TRANSYLVANIAN JOURNAL OF PSYCHOLOGY Special Issue | December 2014

ERDÉLYI PSZICHOLÓGIAI SZEMLE
TRANSYLVANIAN JOURNAL OF PSYCHOLOGY
Special Issue
2014

Clinical and educational applications of Reuven Feuerstein's Mediated Learning Experience Theory: current scientific evidence



Editura Presa Universitară Clujeană

TRANSYLVANIAN JOURNAL OF PSYCHOLOGY

Indexed in PSYCINFO (abstracted) and EBSCO (full text) international databases
Recorded: National Council of Research (CNCSIS-B+)

EDITED BY CLUJ UNIVERSITY PRESS

SPECIAL ISSUE | DECEMBER 2014

Founding editor
Szamosközi István, Ph.D.,
Babeş-Bolyai University, Romania

Advisory board
Raymond DiGiuseppe, Ph.D.,
Saint John University, U.S.A.

Thomas Dowd, Ph.D.,
Kent State University, U.S.A.

Kristine Doyle, Ph.D.,
Albert Ellis Institute, U.S.A.

Arthur Freeman, Ph.D.,
Midwestern University, U.S.A.

Irving Kirsch, Ph.D.,
University of Hull, U.K/Harvard University, U.S.A.

Joseph Lebeer, M.D., Ph.D.,
Universiteit Antwerpen, Belgium

Steven Lynn, Ph.D.,
Binghamton University, U.S.A.

James McMahon, Ph.D.,
Albert Ellis Institute, U.S.A.

Mérő László, Ph.D.,
Eötvös Lóránd University, Hungary

Tullio Scrimali, M.D., Ph.D.
Catania University, Italy

Associate Editors
Oana David, Ph.D.,
Babeş-Bolyai University, Romania/
International Coaching Institute

Mădălina Sucală, Ph.D.,
Icahn School of Medicine at Mount Sinai, U.S.A.

Editorial secretary
Szabó Kinga, Ph.D. student,
Babeş-Bolyai University, Romania

Tehnical editing and design
Máté Tünde Anikó,
Babeş-Bolyai University, Romania

Guest editor
Jo Lebeer, MD, Ph.D.,
University of Antwerp, Belgium

Editor
Szamosközi István, Ph.D.,
Babeş-Bolyai University, Romania

Editorial board
Stephen Ceci, Ph.D.,
Cornell University, U.S.A.

Ioana Cristea, Ph.D.,
Pisa University, Italy

Daniel David, Ph.D.,
Albert Ellis Institute, U.S.A./
Icahn School of Medicine at Mount Sinai, U.S.A.

Demeter Kármen, Ph.D.,
Babeş-Bolyai University, Romania

Claudio Gentili, M.D., Ph.D.,
Pisa University, Italy

Cezar Giosan, Ph.D.,
City University of New York, U.S.A.

Ingrid Hylander, Ph.D.,
Karolinska University, Sweden

János Réka, Ph.D.,
Babeş-Bolyai University, Romania

Viorel Lupu, M.D., Ph.D.,
„Iuliu Hateganu" University of Medicine and Pharmacy, Romania

Silviu Matu, Ph.D.,
Babeş-Bolyai University, Romania

David Mitchell, PhD,
University of Canterbury, New Zealand

Julie Schnur, Ph.D.,
Icahn School of Medicine at Mount Sinai, U.S.A.

Simona Stefan, Ph.D.,
Babeş-Bolyai University, Romania

Aurora Szentágotai, Ph.D.,
Babeş-Bolyai University, Romania

Szokolszky Ágnes, PhD,
University of Szeged , Hungary

Bram Vanderborght, Ph.D.,
Vrije University, Belgium

Photograph on front cover: courtesy of Gary Marcuse,
Face to Face Media, Vancouver, Canada

Contact Address
Cluj-Napoca 400015, Bilascu Gh. No. 37
Tel./Fax: 00-40-264-597-037
epsz.pszichologia.psiedu.ubbcluj.ro, epsz.pszichologia@ubbcluj.ro

RO ISSN 1454 - 797 X

© Transylvanian Journal of Psychology, 2000. All rights reserved.
For copies or reprints of any parts of the journal, please ask for the written approval of the editor.

GUIDELINES FOR SUBMISSIONS

In the T*ransylvanian Journal of Psychology* you may publish researches in the area of psychology, special education and education which answer the formal requirements:

All manuscripts should follow the APA writing style (6th edition) as follows:

o The title page should contain the following: article title, author(s) name, affiliations, mailing address, e-mail, fax, and phone.

o Abstract (max. 250 words) is to be attached in English along with keywords (max. 10 words)

o The manuscript should follow the standard format: line spacing: 2.0, paper size A4 (210*297 mm), font size Times New Roman 12, 1 inch margins.

o Figures and tables should be numbered by Arabic numbers and mentioned in the text (ex. "as you may see it in the 1st table..."). The figures/tables should be submitted in a separate word document, should have a short descriptive title. In general figures should appear in black and white implementation.

References in the text should follow the requirements of the Publication Manual of the American Psychological Association (6th edition). E.g.:

"...Smith et al. (1993) noted that ..."
"...in different researches (Baddeley, 1995; Landau and Smith, 1994; Schmidt, 1993) mentioned that ..."

You must list all bibliographical resources that you have referred in your paper. Please follow the enclosed guidelines (punctuation, order, and name of authors).

In case of books:

Coleman, M., & Gillberg, C. (1986).*Biologiedes syndromes d'autisme.* Qubec:Edisem Inc.

Kulcsár T. (1984). *Iskolapszichológia.* Kolozsvár:Dacia Könyvkiadó

In case of Text books:

Reed, S. (1993). A schema based theory of transfer. In: D. Detterman & R. Sternberg (Eds.), *Transfer on trial*, (pp.39-68). Norwood:Ablex P.C.

Érdi P. (1997). Az agy-tudat-számítógép legendáról. In: Cs. Pléh (szerk.) *A megismeréskutatás egy új útja: A párhuzamos feldolgozás* (o.57-75). Budapest:Typotex.

In case of Journals:

DiGiuseppe, R. (1996). The nature of irrational and rational beliefs: Progress in rational emotive behavior theory. *Journal of Rational-Emotive & Cognitive-Behavior Therapy, 14(1), 5 – 28.* doi: 10.1007/BF02238091

Mennin, D. S., Heimberg, R. G., Turk, C. L., & Fresco, D. M. (2002). Applying an emotion regulation framework to integrative approaches to generalized anxiety disorder. *Clinical Psychology: Science and Practice, 9(1), 85–90. doi: 10.1093/clipsy/9.1.85.*

Érdi P. (1985). Egy analógia nyomában: Neumann János a számítógéprol és az agyról. *Világosság*, 31, 81-85.

You may always list first name of the authors. In case of foreign authors you may separate the abbreviation of second name by a coma. In case of Hungarian authors there is no need for using coma (ex. Pléh Cs. and not Pléh, Cs.).

The articles written in other languages than English, will be translated and lectured by the Editor, who assumes all costs and charges.

C O N T E N T S

Editorial. Clinical and educational implications of Reuven Feuerstein's Mediated Learning Experience Theory: current scientific evidence

Jo Lebeer [1]

On April 29th 2014 Reuven Feuerstein passed away in his 93rd year. He left many with a feeling of "being orphaned", as witnessed by the innumerable condolences which arrived from all over the world at the International Institute in Jerusalem which he had founded in the early sixties under the name of the Hadassah-Wizo-Canada Research Institute, and later was renamed into "The Feuerstein Institute". Letters written by parents of children with developmental or learning disabilities, or adults with sometimes severe brain damage, testified how his approach had changed their lives. Equally, innumerable letters of teachers, psychologists, therapists and colleagues, who had learned with him and from him, showed how widespread his influence was. Some criticists compared him with a guru. Indeed, he was "the father" of a school of thought: structural cognitive modifiability and mediated learning experience, who also developed a unique combination of innovative assessment and intervention methods, and created an international institute where these methods could be taught and applied. But above all, Reuven Feuerstein was in the first place a man who wanted to help disadvantaged children & adults, to go beyond their actual barriers to learning. Barriers could be there for various reasons: a genetic origin, acquired brain damage, lack of learning opportunities due to socio-economic deprivation, or just plain shortcomings in environmental favourable conditions. He had a drive to help these unfortunate individuals to escape from a self- or others-defined status of passive acceptance that "nothing can be done". But quite different from a guru, he had a never-ending endeavour to look for a scientifically grounded theory.

1. University of Antwerp, Faculty of Medicine & Health Sciences, Belgium

Now is the time to reflect on the meaning of Feuerstein's intellectual legacy.

Although hundreds of papers, books and PhD's have been published on Feuerstein's theory and methods, relatively few of them can be retrieved from the databases which are actually regarded by the scientific community as reliable sources of scientific evidence. This might be a reason why "the Feuerstein approach" is relatively less well known.

Rather than telling stories, the Transylvanian Journal of Psychology (TSJP), in accordance with its mission of being a high standard scientific journal, wanted to compose a Special Issue about the relevance of Feuerstein's ideas for the science of psychology as well as for its many applications in education, special needs education, clinical and medical psychology, neuropsychological rehabilitation and other domains.

We invited a number of scholars who have known him, to write a review on a particular theme. Next to that we launched an open call for contributions. Contributions are systematic reviews, scope reviews, and original empirical research reports.

The TSJP is a peer-reviewed international journal, which scope is not only Eastern-Europe as the name would suggest, but to gather and disseminate world-wide scientific information. It is indexed in Psycinfo and full texts are available via Ebsco Academic Premier.

The response to our call made us decide to split the Special Issue dedicated to the intellectual legacy of Reuven Feuerstein in two volumes.

The purpose of this Special Issue volume N°1 is:

1. to provide an update of the theory of Reuven Feuerstein in view of current theories of intelligence, modifiability, neurosciences, etc.
2. to provide a scientific evidence base of the results of implementations which have been done based on Feuerstein's methods or ideas in a clinical or educational context with various populations of adults and children.

The "harvest" is a collection of outstanding papers, whose authors have not been "blind followers" of Feuerstein, but have remained critical scientific thinkers, who often developed their own systems and theories, while paying deep respect for the man who inspired them.

Special Issue N°2 will have more review and research papers on the implementation of Feuerstein's theory of Structural Cognitive Modifiability and

Mediated Learning Experience in the education of individuals at risk of educational failure, and in (re)habilitation of children and adults who have learning difficulties and brain damage in various degrees: some with a registered learning disability or some other cognitive developmental disturbance.

This first volume starts with a reflection of Robert Sternberg of Cornell University, past-president of the American Psychological Association, who discusses the current status of Feuerstein's theory of Structural Cognitive Modifiability (SCM) in relation to theories of intelligence. Sternberg calls Feuerstein's theory as "one of the three most prominent theories of intellectual development of all time, together with Piaget and Vygotsky", comparing his influence to Galileo or Copernicus. Then David Tzuriel of Bar Ilan University gives a brief overview of the theory of Mediated Learning Experience (MLE) and summarizes the extensive research into the developmental aspects of MLE processes carried out informally within the family system and in peers interactions and their effects on children's *cognitive modifiability*. He also describes methodological issues how mediated learning can be operationalized and outcome in terms of modifiability can be measured, using structural equation models.

Jo Lebeer relates current knowledge from the neurosciences with the theory of SCM. He reviews the extensive evidence of the effect of activity-induced neuroplasticity, in animals as well as in human beings, which could form the neurobiological basis of neurocognition through mediated learning experience. MLE is a candidate to constitute the missing link between "activity-driven neuroplasticity" and "self-constructive (re-)organization of the brain", which he has termed "ecological plasticity". Although a direct study of the effect of MLE on neurobiological plasticity mechanisms is still lacking (and would be methodologically hard to realize), Feuerstein's theory was, just as Donald Hebb's theory of the learning synapse, years ahead of this time.

Noami Hadas-Lidor's paper deals with the application of MLE/SCM theory in people with a psychiatric illness. This line of research was also ahead of its time, because nowadays it's becoming more and more clear that people with a schizophrenic psychosis also display cognitive deficits. Hadas shows the effectiveness of MLE-based dynamic cognitive intervention on modifiability. Similarly, Hefziba Lifshitz presents a review on data on modifiability of adults with intellectual disability, showing that these people are able to continue learning for a long time in adult life, thus declaring the concept of a "mental ceiling" to a myth. This is particularly relevant nowadays in the face

of a bulk of research about the risk of development of early Alzheimer's disease in people with Down syndrome.

David Martin in this volume focusses on the cognitive development and modifiability of people with hearing impairment. A summary of research studies on cognitive intervention programs provides a context for the introduction of Feuerstein's Instrumental Enrichment (FIE) Programme as a systematic intervention in different learning environments involving hearing impaired learners; a synthesis of these studies indicates significant positive outcomes for FIE in that context in North America, China and South-Africa. Finally, the only paper in this volume made by a junior, Italian researcher Cristina Vedovelli of the Univeristy of Sassari in Sardinia, deals with an empirical research made in primary schools. Her findings show that the most important modifiability is not so much demonstrable in the children, but more so in the minds and the attitudes of the teacher.

When Sternberg compared Feuerstein to Galileo, he did so to make a point about the need to develop the theory further, based on empirical research, in contrast to creating just a new belief system based on authority. That certainly will be quite a challenge. Taking the Galileo analogy further, that represented a real paradigm shift, with all its characteristics: e.g. being ahead of the current ideas of the time; causing resistance from the "established" authorities (which in Galileo's case lasted a century), even overt hostility; creating believers and disbelievers, etc.. Translated to our times: difficulty to obtain funding from established worldly as well as scientific authorities; difficulty to get published, etc. Does the Feuerstein theory and practice represent a shift in paradigm? The theory that intelligence is structurally modifiable and the practice of interactive assessment certainly are (Lebeer, 2005). The theory of mediated learning, however, is not so revolutionary any more: it can be understood as a socio-constructive theory of cognitive development, which has been supported in one way or another by many prominent psychologists such as William James, Vygotsky, Bruner, Bronfenbrenner and of course Sternberg as well.

The risk of an innovative paradigm however is that people in the face of resistance either drop the idea, or become followers dropping critical thinking. We can observe "a Feuerstein effect", similar to "The Hawthorne Effect" or "Pygmalion Effect" in many of the research reports examining the effect of Instrumental Enrichment. If the method "works", i.e. is claimed to be effective, even though not necessarily showing in statistically significant effects

because of methodological issues (e.g. lack of proper control groups or proper outcome measures), this might be due to the underlying quality of mediation or transmitting a firm belief system by the applicator. After all, the Feuerstein approach depends on the quality of mediation, as he himself stated and also personalized. This represents a particular challenge for future research. In medical literature this is often designated as a negatively loaded "placebo effect". However, rather than viewing this as a "confounding factor" which needs to be avoided, the quality of mediated learning experience is an inherent element of the approach and constitutes its strength. Despite this methodological difficulty, the papers in this volume have all provided scientific evidence of the importance of MLE in cognitive modifiability. However, research remains difficult because human beings, and certainly brain and mind, in relation to their ecology, are highly complex systems and therefore behave in an indeterministic way (Prigogine, 1980). That means that whatever psychological or educational intervention is made, its results will remain largely unpredictable, contrary to what is expected.

When I met Reuven Feuerstein for the first time on a conference in Budapest in 1990, where the presentation of my PhD results about plasticity in children with developmental disabilities matched with the theory of MLE and SCM, I became even more fascinated by the man and his theories and it was the beginning of a long journey. Committed to study it more profoundly, I went to Israel every year for the next 10 years. It has been a privilege and an honour to have been able to study and work closely with Reuven Feuerstein and his team during the past 25 years. Even today, I must confess that most of my daily clinical work as well as teachings are heavily influenced by him. Feuerstein gave me the inspiration and energy to continue dealing with resistance in the daily hassles. Perhaps my father-in-law, once commenting my endeavours laconically with "it's 5% inspiration and 95% transpiration" was right after all.

References

Lebeer, J. (2005), Shifting perspective: dynamic assessment of learning processes in children with developmental disabilities, *Erdélyi Pszichológiai Szemle (Transsylvanian Journal of Psychology), Special Issue on Dynamic Assessment,* 1, 55-85

Prigogine, I. (1980), *From being to becoming*. San Francisco: Freeman

The Current Status of the Theory of Structural Cognitive Modifiability in Relation to Theories of Intelligence

ROBERT J. STERNBERG [1]

Abstract

This articles discusses Feuerstein's place among theorists of intelligence and intellectual development and the pervasive influence his work has had.

Keywords

theories of intelligence, theories of intellectual development, Feuerstein, structural cognitive modifiability

I count myself as among the fortunate that I had the opportunity to get to know Reuven Feuerstein and even to count him as a friend. Although we had not run into each other in recent years, during the 1980s, we frequently ran into each other at conferences and in various meetings in Israel. Perhaps the high point of our interaction was when we debated each other in Alberta, Canada. It was a friendly debate and one in which we struggled to find points on which we disagreed. There just were not so many!

Among contemporary theories of intelligence and of intellectual modifiability, Feuerstein's is unique in having closely associated with it both an assessment (the Learning Potential Assessment Device—LPAD) and a cognitive-training program (Instrumental Enrichment—IE, also called FIE in recognition of its creator, Feuerstein). The theory thus is, in a sense, ahead of all the others in the readiness with which it can both be used and applied in psychological and educational practice.

As I write this short article, I have two books in front of me—Feuerstein, Feuerstein, Falik, and Rand (2002) and Feuerstein, Feuerstein, Falik, and Rand (2006). Both are revisions of earlier work (Feuerstein, 1979, 1980). They are the key works of Feuerstein, I believe, representing respectively his work

1. Cornell University, Department of Human Development, B44 MVR, Ithaca, NY 14853, USA, robert.sternberg@cornell.edu

on the dynamic assessment of learning potential and the enrichment of cognitive functioning. Had Feuerstein produced these two books and nothing more, he still would have found a major place in the pantheon of the great psychologists of all time. Of course, Feuerstein produced far more than just these two books.

To my own way of thinking, there are four "big" current theories of intelligence: Carroll's (1993), which really incorporates virtually all psychometric theories; Gardner's (1983, 1993) theory of multiple intelligences; my own triarchic theory of successful intelligence (Sternberg, 1985, 1997); and, of course, Feuerstein's (2002, 2006) theory of cognitive modifiability. Feuerstein's theory, as mentioned above, is the most comprehensive, because of its ready application. Carroll's theory, representing psychometric theory in general, has had by far the lion's share of attention in the world of education. And Gardner's theory probably has generated the most excitement among educators in my own country, the United States. Among the four theories, Feuerstein's is most closely related to my own theory, in that both theories emphasize (a) the importance of basic cognitive and metacognitive processes underlying human intelligence, (b) the modifiability of intelligence, and (c) the importance of dynamic assessment (see also Sternberg & Grigorenko, 2002).

The three most prominent theories of intellectual development of all time, I believe, are Feuerstein's (2002, 2006) theory, Piaget's (1952, 1972) theory, and Vygotsky's (1962, 1978) theory. Feuerstein is closer to Piaget in his detailed analysis of cognitive structures, but closer to Vygotsky in his ingenious development of dynamic assessment—a development, I gather, which they both achieved relatively independently. In my view, Feuerstein, Piaget, and Vygotsky, perhaps with the addition of Luria (1973, 1976), stand alone among theorists of cognitive development in the scope and power of their thinking. Feuerstein is unique in belonging both to the first group of contemporary intelligence theorists and to the second group of historically distinguished theorists of intellectual development.

The obvious question one might ask is whether Feuerstein's theory and the instruments that came with it are "forever": Are they still as fresh and powerful as they were when they were first introduced in the mid-twentieth-century? Fortunately, the answer to this question is "no." I say, "fortunately", because theories and instruments that stay around forever are not truly scientific—either because they have failed to generate research or because they

have failed to generate any interest at all. As I have said to my own students, the best they can do is not to become my acolytes, but rather, to become the developers of the theories, research, and instruments that supersede mine.

Two of the greatest minds of all times in the field of astronomy were Galileo and Copernicus, but imagine if astronomy had never moved beyond their observations, or physics beyond Newton's. Science is different from the humanities in a key respect: Great works in the humanities take their place in an eternal pantheon, where only the interpretations change, whereas great works in the sciences are part of an eternal process of development and change. The greatest compliment, as, say in the work of Skinner, is when someone can work in a field and not even have to cite you because your work has become so fundamental to the field that it is fully incorporated into it. Not everyone who draws on Feuerstein's ideas cites him any more, because his ideas have so much become the fabric of the way we think about cognitive processing.

It is one of the great honors of my life that I got to know Reuven Feuerstein just a little, and perhaps if I am extremely lucky, I will become reacquainted with him in another, and I hope better, world!

References

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* New York: Cambridge University Press.

Feuerstein, R. (1979). *The dynamic assessment of retarded performers: The learning potential assessment device, theory, instruments, and techniques.* Baltimore, MD: University Park Press.

Feuerstein, R. (1980). *Instrumental enrichment: An intervention program for cognitive modifiability.* Baltimore, MD: University Park Press.

Feuerstein, R., Feuerstein, R. S., Falik, L., & Rand, Y. (2002). *The dynamic assessment of cognitive modifiability: The Learning Propensity Assessment Device: Theory, instruments, and techniques.* Jersualem, Israel: ICELP Press.

Feuerstein, R., Feuerstein, R. S., Falik, L., & Rand, Y. (2006). *Creating and enhancing cognitive modifiability: The Feuerstein Instrumental Enrichment Program.* Jerusalem, Israel: ICELP Press.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Gardner, H. (1993). *Multiple intelligences: The theory in practice.* New York: Basic Books.

Luria, A. R. (1976). *Cognitive development: Its cultural and social foundations.* Cambridge, MA: Harvard University Press.

Luria, A. R. (1973). *The working brain.* London: Penguin.

Luria, A. R. (1976). *Cognitive development: Its cultural and social foundations.* Cambridge, MA: Harvard University Press.

Piaget, J. (1952). *The origins of intelligence in children.* New York: International Universities Press.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence.* New York: Cambridge University Press.

Sternberg, R. J. (1997). *Successful intelligence.* New York: Plume.

Sternberg, R. J., & Grigorenko, E. L. (2002). *Dynamic testing.* New York: Cambridge University Press.

Piaget, J. (1972). *The psychology of intelligence.* Totowa, NJ: Littlefield, Adams.

Vygotsky, L. S. (1962). *Thought and language.* Cambridge, MA: MIT Press. (Original work published 1934)

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Mediated Learning Experience (MLE) and Cognitive Modifiability: Theoretical Aspects and Research Applications[1]

DAVID TZURIEL [2]

Abstract

Feuerstein's concept of Mediated Learning Experience is defined as a unique mode of interaction between the mediator (e.g., parent, teacher or peer) and the learner. It starts from a very early age in the spontaneous interactions between parents and their children, or grandparents with grandchildren and continues later with peers and in more structured interactions with teachers. In the current paper the focus is developmental aspects of MLE processes carried out informally within the family system and in peers interactions and their effects on children's cognitive modifiability. The objectives of this paper are: (a) to present the theory of MLE as a proximal factor of cognitive modifiability (b) and to demonstrate empirical validation for the role of MLE strategies in enhancing children's cognitive modifiability. The first section provides some definitions of the main concepts and a brief description of the MLE theory. The second and main section discusses selected research findings demonstrating the impact of MLE strategies in facilitating cognitive modifiability. In the third section some conclusions will be discussed, followed by suggestions for future research.

Keywords

Feuerstein, Structural Cognitive Modifiability theory, Mediated learning experience theory, review, peer mediation, cognitive development

---

1. This paper is based on an earlier paper: Tzuriel, D. (2013). Mediated learning experience strategies and cognitive modifiability. Journal of Cognitive Education and Psychology, 13, 59-80. Some modifications are made to reflect recent research on the same issues and some changes in organization of the sections of the paper. I thank the JCEP for their permission to use parts of my paper for the current paper. Above all I want to thank H. Carl Haywood and Robert Sternberg for their help in editing the earlier version of the paper published in JCEP.
2. professor of psychology at Bar Ilan University, Ramat Gan, Israel. David.Tzuriel@biu.ac.il

Introduction

Mediated learning experience (MLE, Feuerstein, Rand & Hoffman, 1979) is an interactive unique mode of interaction between the mediator (e.g., parent, teacher or peer) and the learner. It starts from a very early age in the spontaneous interactions between parents and their children, or grandparents with grandchildren and continues later with peers and in more structured interactions with teachers. In the current paper the focus is developmental aspects of MLE processes carried out informally within the family system and in peers interactions (e.g., Feuerstein, et al., 1979; Feuerstein, Feuerstein, Falik, & Rand, 2002) and their effects on children's *cognitive modifiability*.

A growing body of theory and research in the last three decades supports the crucial role of active parental and peer mediation in enhancing children's cognitive development (Belsky, Goode, & Most, 1980; Berk & Spuhl, 1995; Bornstein & Tamis-LeMonda, 1990; Bradley & Caldwell, 1984; Clarke-Stewart, 1993; Cristofaro, & Tamis-LeMonda, 2012; Klein, 1996; Laosa, 1982; Ramey, Farran & Campbell, 1979; Parker, Boak, Griffin, Ripple, & Peay, 1999; Rodriguez, et al., 2009; Tamis-LeMonda, Bornstein, & Baumwell, 2001; Tzuriel, 1996, 1999, 2001; Vygotsky, 1978; Wachs, 1992). The literature is replete with specific interaction strategies that enhance children's thinking skills and cognitive processes. Researchers suggested a variety of parents' behaviors such as *distancing* (e.g., Siegel, 1982), *scaffolding* (e.g., Wood, 1989; Wood, Bruner, & Ross, 1976), *responsiveness* (e.g., Bornstein, Azuma, Tamis-LeMonda, & Ogino, 1990; Bornstein & Tamis-LeMonda, 1990; Vibbert & Bornstein, 1989), and *mediated learning experience* (Feuerstein, et al., 2002; Klein, 1988, 1996; Tzuriel, 1999, 2001, 2011a, 2011b). The effects of these strategies on children's cognitive development are expressed along a continuum of concepts from specific behaviors (e.g., gazing) to general thinking skills (e.g., reasoning, metacognitive competence, cognitive plasticity, cognitive modifiability).

The objectives of this paper are: (a) to present the theory of MLE as a proximal factor of cognitive modifiability (Feuerstein et al., 1979), (b) and to demonstrate empirical validation for the role of MLE strategies in enhancing children's cognitive modifiability. In the first section of this paper I will provide some definitions of the main concepts and describe briefly the MLE theory. In the second and main section I will discuss selected research findings demonstrating the impact of MLE strategies in facilitating cognitive modifia-

bility. In the third section some conclusions will be discussed, followed by suggestions for future research.

Theoretical Foundations of MLE

Definitions of MLE and Cognitive Modifiability

MLE processes describe a special quality of interaction between a mediator and a learner (Feuerstein, et al., 1979; Tzuriel, 1999, 2002, 2011a). In this qualitative interactional process, parents or substitute adults or peers interpose themselves between a set of stimuli and the developing human organism (learner) and modify the stimuli for him/her. MLE processes are considered as the proximal factor that explains cognitive modifiability. *Cognitive modifiability* is defined as the individual's propensity to learn from new experiences and learning opportunities and to change one's own cognitive structures. Feuerstein's MLE theory is in some aspects similar to Vygotsky's (1978) concepts of the *zone of proximal development* and *internalization* and the concept of *scaffolding* (Wood, Bruner, & Ross, 1976), which have captured the interest of many developmental psychologists and educators (e.g., Rogoff, 1990; Valsiner, 1987; Wertsch, 1985).

The MLE Theory

A basic assumption of MLE theory is that individuals learn by way of two main modalities: *direct exposure* to stimuli and *mediated learning experience* (see model in Figure 1).

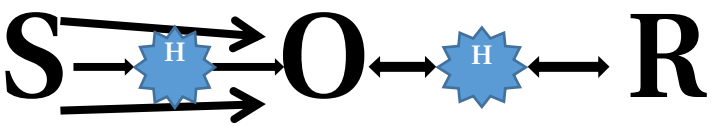


Figure 1. The Mediated Learning Experience (MLE) Model (Copied by permission from Reuven Feuerstein, The International Center for Enhancement of Learning Potential).

Direct exposure is characterized by unmediated encounters of individuals with stimuli in the environment. In Figure 1 the top and bottom arrows from the Stimuli (S) to the Organism (O, learner) represent the direct exposure. In MLE interaction, on the other hand, learning is carried out by means of an experienced adult, usually the parent, who interposes him/herself between the child and the world of stimuli. This is represented by arrows directed from the S to the H (Human) and from the H to the O. The mediator (H) modifies the stimulus in various ways and presents it to the child (O) so that it can be registered efficiently. The mediator presents stimuli to the children by modifying their frequency, order, intensity, and context, by arousing in the children curiosity, vigilance, and perceptual acuity, and by trying to improve and/or create in the child the cognitive functions required for temporal, spatial, and cause-effect relationships.

Parents mediate to their children not only the external stimuli but also their own responses to the stimuli. This is represented by the arrows from the child (O) and his/her own response (R). Mediational processes are complex, circular, and depend not only on parental characteristics but also on children's cognitive strengths and deficits, motivational orientation, emotional needs, behavioral tendencies, stimulus characteristics, and situational conditions. It should be emphasized that the H is elastic; it expands (i.e., mediation is enhanced) or shrinks (i.e., withdrawal of mediation) as a function of the child's level of understanding, task difficulty, and situational conditions that determine effectiveness of learning.

The MLE processes are gradually internalized by the child and become an integrated mechanism of change within the child. Adequate MLE interactions facilitate the development of various cognitive functions, learning sets, mental operations, strategies, and need systems. The internalized MLE processes allow developing children later on to use them independently, to benefit from learning experiences in diverse contexts, and to modify their cognitive system by means of self-mediation. The more the child experiences MLE interactions, the more he/she is able to learn from direct exposure to formal and informal learning situations, regardless of the richness of stimuli they provide.

Lack of MLE may be derived from two broad categories: (a) lack of environmental opportunities for mediation, and (b) inability of the child to benefit from mediational interactions, which are potentially available. In the first case lack of mediation derives from parents' low educational level, traumatic

life events, lack of parents' awareness to the importance of mediation, and lack of knowledge and/or sophistication in applying MLE strategies. In the second case, children might suffer from physical and/or intellectual disabilities that act as barriers to register mediation offered to them.

Feuerstein conceived MLE interactions as a *proximal* factor that explains individual differences in learning and cognitive modifiability. Factors such as organic deficit, poverty, socioeconomic status, and emotional disturbance are considered to be distal factors, that is, factors that might correlate with learning ability, but which affect the child through the proximal factor of MLE. Feuerstein and Feuerstein (1991) suggest 12 criteria of MLE, but only the first three are conceived as necessary and sufficient for an interaction to be classified as MLE: *Intentionality and Reciprocity*, *Meaning,* and *Transcendence* (see description below). These three criteria, which are responsible for the individual's cognitive modifiability, are also considered to be universal and can be found in all races, cultures, ethnic groups, and socioeconomic strata. Mediation does not depend on the language modality or content and can be carried out by gestures, mimicry, and verbal interaction, provided that the three major criteria are present. The other nine criteria are task-dependent, strongly related to culture, and reflect variations in cognitive styles, motivation, type or content of skills mastered, and the structure of knowledge.

The first five MLE criteria were operationalized and observed in interactions of mother-child (e.g., Klein, Weider & Greenspan, 1987; Klein, 1988, 1991, 1996; Lidz, 1991; Tzuriel, 1999, 2001, 2011a, 2013), peer-assisted learning (e.g., Tzuriel & Shamir, 2007, 2010), siblings (Klein, Zarur & Feldman, 2002; Tzuriel & Hanuka-Levy, in press; Tzuriel & Rokach, 2010), and teacher-student instruction (e.g., Tzuriel & Gross, 1992; Tzuriel, Kaniel, Zeliger, Friedman, & Haywood, 1998; Remer & Tzuriel , 2011).

The first five MLE criteria that were operationalized for research are as follows:

(a) *Intentionality and Reciprocity* refers to a mediator's deliberate efforts to change a child's attention, awareness, perception, processing, or reaction. Mediation for Intentionality alone is inadequate without the child's reciprocity. Reciprocity is defined when the child responds vocally, verbally, or nonverbally to the mediator's behavior. For instance, Intentionality and Reciprocity are observed when a caregiver intentionally offers a toy to a child or verbally focuses a child's attention on some aspect of the environment and the child undeniably responds. This criterion is considered crucial for the "ignition" of the mediation process and later on for development of feelings of competence and self-determination.

(b) *Mediation of Meaning* refers to a mediator's response that conveys the affective, motivational, and value-oriented significance possessed by the presented stimuli. This can be expressed verbally by enlightening the present context, relating it to other events, and emphasizing its importance and value, or nonverbally by facial expression, tone of voice, repetitious actions and rituals. According to MLE theory, children who experience mediation of meaning will actively connect future meanings to new information rather than passively wait for meaning to appear.

(c) *Mediation of Transcendence* refers to interactions in which the mediator provides both the immediate or concrete needs of the children and attempts to reach additional goals that are beyond the specific situation or activity. In mother-child interactions the mother may go beyond the specific experience by teaching strategies, rules, and principles in order to generalize to other situations. For instance, in a play situation, the mother may mediate the rules and principles that direct a game and generalize them to other situations. Mediation for Transcendence depends on the first two criteria, intentionality/reciprocity and meaning, though the combination of all three criteria enhances the development of cognitive modifiability and expands the individual's need system.

(d) *Mediation of Feelings of Competence* is observed in interactions in which a mediator conveys to a child that he or she is capable of functioning both successfully and independently. The mediator may organize the surroundings in order to supply opportunities for success,

interpret them to the child, and reward attempts to master the situation or deal with problems efficiently.

(e) *Mediation of Control of Behavior* refers to interactions in which a mediator regulates a child's reaction, depending on the child's reactive style and the task demands. The mediator may either reduce impulsivity or accelerate the child's behavior. Control of behavior can be mediated in various ways, such as arousing awareness to task characteristics and suitable responses, analyzing the task components, modeling of self-control, and providing metacognitive strategies.

An integrative component of the MLE approach is related to the conceptualization of the developing individual as an open system that is modified by mediating agents. This component has led to both theoretical elaboration of dynamic assessment (DA) of learning potential (Feuerstein et al., 2002; Tzuriel, 2001) and development of an applicative system of measuring cognitive modifiability (Embretson, 1992; Haywood & Tzuriel, 1992; Lidz & Elliott, 2000; Sternberg & Grigorenko, 2002; Tzuriel, 1997, 2001, 2012). The term DA refers to an assessment of thinking, perception, learning, and problem solving by an active teaching process aimed at modifying cognitive functioning.

MLE and Cognitive Modifiability: Scientific Research

Methodological Aspects

Observation of MLE Processes

Research on MLE processes and cognitive modifiability has been carried out using both observation techniques and a DA procedure. Usually the interaction has been videotaped and analyzed later by trained observers using the *Observation of Mediation Interaction* (OMI, Klein, et al., 1987). Klein (1988) has preferred to assess the quality of mother-child interaction by a *macroanalytic* rather than by a *microanalytic* approach. For example, when a parent focuses the child's attention on some aspects of a stimulus (handing an object to a child), it has been coded as behavior reflecting *focusing* only if it was reciprocated by the child's response. Whenever the parent made an attempt

to generalize a rule, suggest a concept, or a principle that goes beyond the concreteness of the situation, it is coded as *expanding*, regardless of the specific content being conveyed. The basis of Klein's observation system is an interaction "event" that might contain one or more MLE criteria.

An advantage of the MLE molar observational approach is its allowance of the identification of meaningful patterns of continuity in parents' behavior across a developmental dimension. The qualitative characteristics of the MLE observation approach allow comparison of similarities in behavioral patterns across generations and coincide with other patterns such as emphasis on holism and the need to look at the meaning of behavior within a psychological context rather than as isolated events (Santostefano, 1978; Sroufe, 1995; Sroufe & Waters, 1977). One of the basic assumptions behind the OMI is that observation of MLE processes in a semi-natural experimental context reflects the spontaneous MLE processes at home. This assumption has been supported in several studies (e.g., Klein, 1988; Klein & Aloni, 1993).

In Tzuriel's studies dyads of mothers with their children (or peers or siblings) were videotaped during free-play and/or structured situations and analyzed later by the OMI. Each dyad was videotaped in a semi-natural context of an adjunct room of the kindergarten, or in the child's home; both places were familiar to children and their mothers. In the free-play condition, which took 15 minutes, sets of games and play materials were placed on the table. The only instruction to the mother was: "you can play in whatever you want with your child in the next 15 minutes, try to do what you are used to doing at home." In the structured situation, the dyad was given one or two problem-solving tasks which mother had to teach her child. The tasks were composed of teaching analogies, picture arrangement, and/or inferences; all tasks were not related to the tasks used in the DA procedure. It should be emphasized that while the tasks were explained to the mothers no directions were given as to how to teach the child. The OMI was found as strongly reliable as measured by inter-rater reliability and as a robustly valid in many studies (Klein, 1996; Tzuriel 1999, 2013). A summary of inter-rater reliability coefficients compiled from 12 samples is presented in Table 1. As can be seen in Table 1 the inter-rater reliability coefficients across the samples are high and significant.

Table 1.
Reliability Coefficient of MLE Strategies in Different Studies

MLE Criteria	Tzuriel & Ernst (1990)	Tzuriel & Weiss (1998)	Tzuriel, et al., (1998)	Tzuriel & Weitz (1998)	Tzuriel & Hanuka-Levy (2014)		Tzuriel & Weitz (2007)	Isman & Tzuriel (2008)	Tzuriel & Shomron (2009)	Tzuriel & Rokach (2009)	Tzuriel & Caspi (2010)	
					M-C	Siblings					M-C	Peers
Intentionality & Reciprocity	.54	.42	.75**	.95***	.82**	.77**	.95***	.87***	.91***	.97***	.79**	.90***
Meaning	.85**	.73*	.78**	.86**	.88***	.91***	.86**	.89***	.90***	.99***	.87**	.98***
Transcendence	.80**	.83**	.98***	.86**	.86**	.94***	.86**	.96***	.95***	.96***	.86**	.77**
Feelings of Competence	.87**	.94***	.80**	.86**	.89***	.97***	.95***	.94***	.93***	.97***	.86**	.76**
Regulation of Behavior	.55	.85**	.81**	.95***	.90**	.94***	.85**	.91***	.92***	.95***	.90**	.74**
MLE – Total	.93***	.93***	.94***	.85**	.86**	.90***	.89***	.92***	.92***	.97***	.86***	.82**

M-C-Mother-Child
*p< .05 **p< .01 ***p< .001

Measuring Cognitive Modifiability

Cognitive modifiability was measured in most studies by DA which allows recording of change criteria. The conceptualization behind using change criteria as predicted outcome of MLE interaction is that interactions by which the child is mediated how to process information efficiently are more closely related to measures of modifiability, than they are to standardized static measures of intelligence. The mediational strategies used within the DA procedure have more "matching value" to learning processes in other life contexts than do conventional static methods and therefore give better indications about future changes of cognitive structures. Accumulating evidence from educational research provides indications that a score reflecting individual differences in "modifiability" added substantially to the predictive power of learning (Embretson, 1992) and future academic success (Haywood & Lidz, 2007; Sternberg & Grigorenko, 2002; Tzuriel, 2000a, 2000b; Tzuriel, Kaniel, Kanner, & Haywood, 1999).

Use of Structural Equation Modeling (SEM) to Validate the MLE Theory

A comprehensive venue for data analysis used in many studies is the *structural equation modeling (SEM)* analysis. The use of SEM for the validation of MLE theory seems to be a promising approach since we can design complex models and infer causal relations among variables without having to use experimental designs. Also the nature of the variables involved in testing the theory are not always given to experimental manipulations, and the accumulated effects that several variables have on outcome variables are not easily given to manipulate simultaneously. The holistic approach used in SEM contributes to understanding of the conceptual whole more than the sum of fragmentary separate analyses. The SEM analysis is considered in the literature to support causal inferences (Joreskog & Sorbom, 1984) and was found as useful statistical tool in MLE strategies and cognitive modifiability research.

A summary of characteristics of studies relating MLE interactions to cognitive modifiability is presented Table 2. The studies in Table 2 are limited only to those in which MLE interactions were observed and analyzed using the OMI and cognitive modifiability was examined using DA measures for young children (i.e., K-Grade 3). In most studies the focus was on mother-child interactions whereas in other studies mediation was examined also with peers (Shamir & Tzuriel, 2004; Tzuriel & Caspi, 2010) and siblings (Tzuriel & Hanuka-Levy, 2014; Tzuriel & Rokach, 2010).

Table 2.
Studies on MLE Strategies and Cognitive Modifiability: Sample Characteristics, DA Measures, Analyses Used, and MLE Strategies

Study	Grade	Age	n	Characteristics	Dyad	DA Tests	Analysis	MLE Strategies Explaining Cognitive Modifiability
1.Tzuriel &Eran (1990)	K	5-6	47	Typical	M-C	CITM	Regression	MLE Total
2. Tzuriel & Ernst (1990)	K	5-6	48	Typical	M-C	CATM	SEM	Transcendence
3. Tzuriel, Kaniel & Yehudai (1994)	K	5-6		Ethiopian Immigrants	T-C	CATM	Regression	None
4. Tzuriel (1996)	K	5-6	48	Typical	M-C	CATM	Regression	MLE-Total Feelings of Competence
5. Tzuriel & Weiss (1998)	2	7-8	54	Typical	M-C	CITM	SEM	Transcendence Regulation of Behavior
6. Tzuriel & Hatzir (2002)	K	5-6	60	Typical	M-C + F-C	CATM Complex Figure	Regression	Transcendence Intentionality and Reciprocity
7. Tzuriel & Weitz (1998)	3-4	5-8	56	LBW+ NBW	M-C	CATM Complex Figure	Regression	Transcendence Regulation of Behavior
8. Tzuriel &Weitz (2007)	3-4	9-10	85	LBW+ NBW	M-C	Analogies (CMB) Complex Figure	Regression	Transcendence
9. Tzuriel & Shomron (2009)	2-4	7-10	100	LD	M-C	Analogies (CMB)	SEM	Transcendence
10. Tzuriel & Bettan (2007)	K	5-6	72	ADHD	M-C	Analogies (CMB)	SEM	Transcendence
11. Tzuriel & Rokach (2009)	3-6	8-12[a]	90	Typical	Siblings	Analogies (CMB)	SEM	Transcendence
12. Tzuriel &Caspi (2010)	3	8-9[a]	100	Typical	M-C + Peers	Analogies (CMB) Seria-Think	MANOVA Regression	Transcendence

[a]Age of older sibling
Reading: LBW-Low Birth Weight, NBW-Normal Birth Weight; LD-Learning Disabled; ADHD-Attention Deficit Hyperactive Disorder
M-C-Mother-Child; F-C-Father-Child; T-C-Teacher-Child; CATM-Children's Analogical Thinking Modifiability; CITM-Children's Inferential Thinking Modifiability; CMB-Cognitive Modifiability Battery; SEM-Structural Equation Modeling

The most striking finding emerging from Table 2 is that in 9 out of 12 studies the strategy that has emerged as most powerful in predicting cognitive modifiability was *mediation for Transcendence* (expanding); a finding that will be discussed later.

In the following I will present (a) some studies demonstrating the relation between parent-child MLE interactions and cognitive modifiability among typically developing children and (c) among children with learning difficulties, (c) the effects of intervention for peer-mediation on cognitive modifiability, (c) sibling's MLE interaction and cognitive modifiability. Because of space limitation only example studies are presented.

Mother-Child MLE Interactions and Children's Cognitive Modifiability among Typically Developing Children

The main objectives of the studies reported below were (a) to validate the relationship between MLE processes and children's cognitive modifiability and especially the relative strength of distal and proximal factors (MLE) in predicting cognitive modifiability, (b) to find the specific combination of MLE strategies that best predicts cognitive modifiability.

A major finding repeated in almost all studies was that children's Post-teaching scores on DA measures were better predicted by MLE mother-child interactions than by static test scores (or Pre-teaching DA scores). In our first study, a sample of kibbutz mother-child dyads (n=47) was observed in a free-play situation for 20 minutes (Tzuriel & Eran, 1990). The kibbutz young children (22 boys and 25 girls, age range = 4:7 to 7:8 years) were then administrated the *Raven Colored Progressive Matrices* (CPM, Raven, 1956) and the *Children's Inferential Thinking Modifiability* test (CITM, Tzuriel, 1992). Three scores are derived from the CITM: Pre-teaching, Post-teaching, and Gain. In a series of three stepwise regression analyses, the CPM and MLE-Total scores were assigned as predictors of the Pre-teaching, Post-teaching, and Gain scores, respectively. A schematic presentation of the findings are presented in Figure 2.

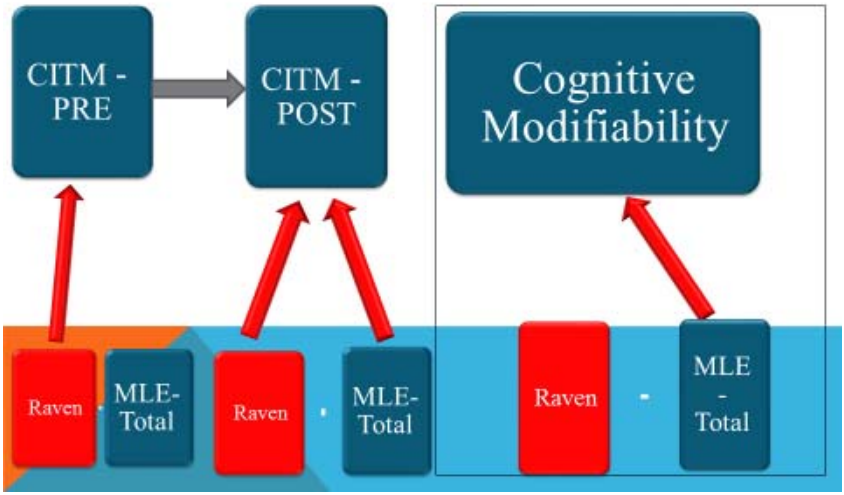


Figure 2. Schematic Description of the Prediction of CITM Pre- and Post-Teaching and of Cognitive Modifiability by MLE Strategies and Raven's Score

The findings revealed that the Pre-teaching (static) was predicted only by the CPM (R =.40, $p < .004$), the -Post-teaching was predicted by both MLE-Total and CPM (R =.69, $p < .002$), and the Gain was predicted only by MLE-Total score (R =.43, $p < .001$). The Pre-teaching score was predicted only by the CPM scores, as both tests are actually conventional static tests. This result verifies what is commonly known, that the common variance of two cognitive tests is higher than the common variance of a cognitive test with an observed behavior (i.e., MLE mother-child interactions). The Post-teaching score seems to be composed of two components: the previously acquired inferential skills as manifested in children's Pre-teaching performance and what has been learned as a result of mediation given by the examiner in the teaching phase of the DA procedure. It is plausible to assume that the first component (Post-teaching score) is attributed to the CPM score, and the second component (Post-teaching score) to the MLE-Total score. When the Gain

scores were taken as the criterion variable, only MLE-Total emerged as a significant predictive variable. This predictability pattern across the three regression analyses is quite intriguing as it shows that *the more the criterion score was saturated with teaching effects, within the testing DA procedure, the higher was the variance contributed by MLE mother-child processes.*

The SEM analysis approach was applied in a series of six studies (Bettan & Tzuriel, 2007; Tzuriel & Ernst, 1990; Tzuriel & Rokach, 2010; Tzuriel & Shomron, 2010; Tzuriel & Weiss, 1998; Weitz & Tzuriel, 2007). In the first study by Tzuriel and Ernst (1990), a sample of kindergarten children (n = 48) and their mothers were observed interacting in free-play and structured situations. The children were then tested by the *Children's' Analogical Thinking Modifiability* test (CATM, Tzuriel & Klein, 1985). In the second study by Tzuriel and Weiss (1998), a sample of mother-child dyads were observed interacting in free-play and structured situations. The children (Grade 2, n = 54) were then tested with the CITM test. Both the CATM and CITM are DA tests of learning potential. In both studies the SEM approach was applied to test a theoretical model of the effects of distal and proximal factors on cognitive modifiability. Figures 3 and 4 describe the findings of the SEM of Tzuriel and Ernst (1990) and of Tzuriel and Weiss (1998), respectively. The two studies are different in the set of distal variables used, the age of subjects, and the DA tests used (see Table 1).

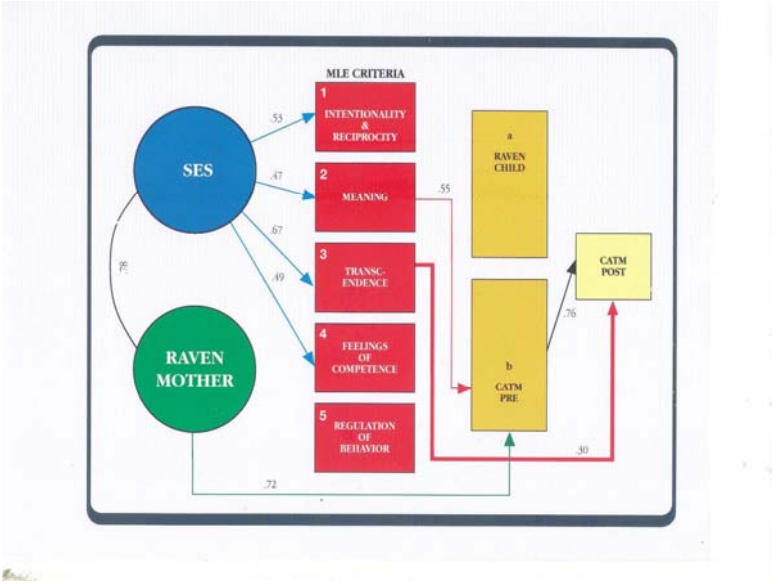


Figure 3. Structural Equation Analysis- Effects of Distal Factors (Mothers' Socioeconomic Level and Intelligence) and Proximal Factors (MLE Strategies) on Children's Cognitive Modifiability (Copied by permission from *International Journal of Cognitive Education and Mediated Learning, 1*, 119-135).

The findings in Figure 3 show that the MLE criteria of Transcendence predicted the CATM Post-teaching score more than did children's static test score (i.e., the CPM administered in a standard way). As can be seen in Figure 3, the MLE criterion of Meaning predicted the Pre-teaching score, whereas the MLE criterion of Transcendence predicted the Post-teaching score. Mediation of Meaning, which involves labeling of information, was crucial for first encounters with information such as the analogies presented to children in the CATM-Pre-teaching phase. Mediation for Transcendence, on the other hand, was found to be important when performance depends on learning of abstract rules, cognitive strategies, and principles such as those taught in the Teaching phase and later tested in the Post-teaching phase. The authors explained the results in that the children whose mothers used high level of mediation for Meaning internalized this mechanism of mediation and therefore performed better on the Pre-teaching phase. Children whose mothers used a high level of mediation for Transcendence internalized this specific mecha-

nism and used it later in other learning contexts. These results support the "specificity" (Wachs, 1992) of the MLE criteria as predictors of cognitive outcomes.

Tzuriel and Weiss (1998) reported similar findings by using a different DA measure - the CITM, for a different sample - older children in grade 2, and a different set of distal factors. A model of distal and proximal factors was constructed to explain causal paths among distal factors (e.g., mothers' acceptance-rejection, and children's personality orientation) and proximal factors (MLE) and between the proximal factors and cognitive modifiability defined by the Post-teaching score of the CITM.

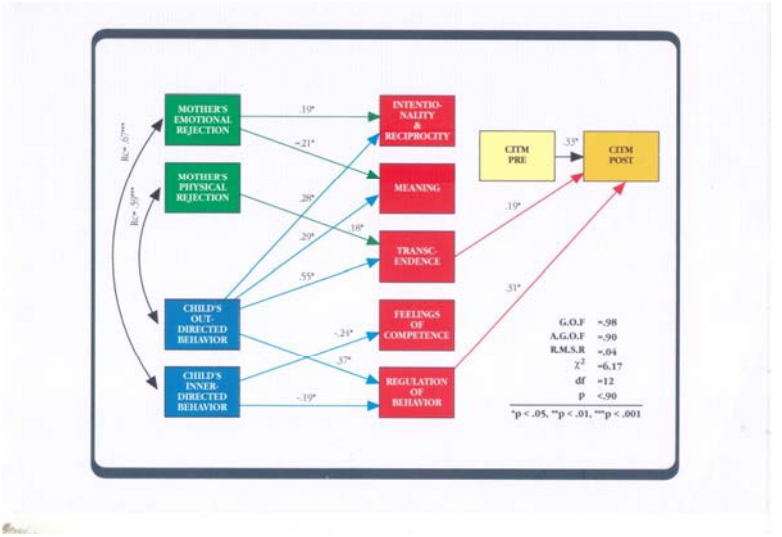


Figure 4. Structural Equation Analysis- Effects of Distal Factors (Mothers' Acceptance/Rejection and Children's Personality Orientation) and Proximal Factors (MLE Strategies) on Children's Cognitive Modifiability (Copied by permission from *Early Development and Parenting*, 7, 79-99.).

The findings in Figure 4 show that MLE strategies of *Transcendence* and *Regulation of Behavior* explained the children's Post-teaching score but *not* the Pre-teaching score. Both MLE criteria reflect a typical mother-child interaction in which the mother is involved in mediating rules and principles (Transcendence) and monitoring the flow of the children's behavior (Regulation). The findings become even clearer when we compare the MLE criteria

to task analysis of the CITM problems. Successful performance of the CITM problems requires a systematic exploration, planning behavior, hypothetical thinking, applications of cognitive rules, and generalization of principles. These cognitive functions (Feuerstein, et al., 1979) are perceived to be dependent not only on adequate internalization of general mediational processes, but more specifically on self-regulation and application of generalized principles and rules – cognitive processes that correspond to the MLE criteria found to be predictive of cognitive modifiability. It seems that these two MLE components, acquired during normal mother-child interactions, were assimilated by the children and equipped them with the thinking tools and mechanisms that are required later in other tasks and learning settings. When similar mediation for Transcendence and Regulation of Behavior are provided in other learning situations, these children can retrieve their previous mediational experiences, apply them efficiently with different tasks, and modify their cognitive structures.

The overall results of the two SEM analyses reported above were congruent with MLE theory, according to which proximal factors explain individual differences in children's cognitive functioning, whereas distal factors (i.e., SES-level, child's personality, mother's acceptance-rejection of the child) do not have a direct effect on children's cognitive factors, although they do explain some of the proximal factors.

Mother-Child MLE Interactions and Children's Cognitive Modifiability among Children with Learning Difficulties

In several studies the relation between MLE and cognitive modifiability was investigated in samples where the children had learning difficulty (e.g., Bettan & Tzuriel 2007, Tzuriel & Weitz, 2007, 2010, Tzuriel & Shomron, 2019). In contradiction to the MLE theory, in two studies distal factors were found as directly predicting cognitive modifiability. For example, in the Bettan and Tzuriel (2007) study carried out on kindergarten children with ADHD, two MLE strategies (in structured teaching situation) predicted, as expected, cognitive modifiability: mediation for Meaning (β = .26) and mediation for Transcendence (β =.46). However, unexpectedly, two distal factors also explained directly the children's cognitive modifiability: Severity of the ADHD (β = -.26) and mother's socioeconomic level (β =.46). The meaning of these findings is

that the higher the severity of the child's ADHD and the lower the mother's socioeconomic level, the lower is the cognitive modifiability of the child. Similarly, in a study by Tzuriel and Shomron (2007) on children with learning disability, one distal factor: *Home Observation for Measurement of the Environment* (HOME, Bradley, Caldwell, Rock, Hamrick & Harris, 1988) was found as directly explaining cognitive modifiability (β =.60) together with a combined score of four MLE strategies (β. = .41). These empirical findings raise the question whether, with children experiencing learning difficulties, the distal factors might also influence directly the child's cognitive modifiability, a finding that contradicts the MLE theory. A possible explanation for these findings might be related to the sample characteristics. It might be that in samples of children with learning difficulties (e.g., ADHD, LD), even the best mediation, given naturally by mothers, is not enough to overcome or "nullify" the strength of the distal factor. In other words, the mothers of children with learning difficulties, who were observed during spontaneous interactions with their children, had no prior training for mediation. *It is plausible to assume that should mothers receive training for higher level of mediation, the effects of the distal factors would be reduced significantly or disappear.* Our findings suggest an elaboration of MLE theory. While in typically developing children distal factors *do not* affect directly cognitive modifiability, as suggested in the theory, in samples of children with learning difficulties, a much higher level of mediation is required to overcome the effects of the distal factors. In other words, in situations where children demonstrate learning or behavioral difficulties, distal factors can directly affect cognitive modifiability. The MLE process must be more powerfully directed toward amelioration of disability when the distal factors are salient.

This specific proposition should be investigated in further research where mothers of children with learning difficulties will be assigned to experimental and control groups. Mothers in the experimental group will receive a program of mediation and be compared with a control group of mothers who do not receive a program. Mother-child MLE interactions should be observed a year later to let the effects of the program internalized and assimilated into the mother-child interactional system. The children should then be tested by cognitive modifiability measures. My expectation is that distal factors will directly affect children’s cognitive modifiability in the control group but will be significantly lower or disappear in the experimental group.

Intervention for Peers Mediation and Children's Cognitive Modifiability

Recent research of peer mediation showed that participation in a *Peer Mediation with Young Children (PMYC)* program improved children's MLE strategies (e.g., Shamir & Tzuriel, 2004; Tzuriel & Caspi, 2010; Tzuriel & Shamir, 2010) and enhanced their *cognitive modifiability* (Tzuriel & Shamir, 2007, 2010; Tzuriel & Caspi, 2010) and math performance (Shamir, Tzuriel & Guy, 2007; Shamir, Tzuriel, & Rozen, 2004). Because of space limits, other programs based on the MLE approach are not included in this article and readers are referred to the relevant research literature (e.g., Feuerstein, Rand, Hoffman & Miller, 1980; Greenberg, 1990; Haywood, Brooks, & Burns, 1986, 1992; Samuels, Killip, MacKenzie, & Fagan. 1992; Tzuriel & Eiboshitz, 1992; Tzuriel & George, 2009; Tzuriel, Kaniel, Kanner, & Haywood, 1999; Tzuriel, Kaniel, Zeliger, Friedman, & Haywood. 1998).

The PMYC program is a relatively new peer-assisted learning model that draws on both Vygotsky's (1978) concept of *zone of proximal development* and Feuerstein's *MLE* theory (Feuerstein, et al., 1979). The concept of peer mediation was developed recently (Shamir & Tzuriel, 2004; Shamir, Tzuriel, & Rozen, 2006; Shamir, Tzuriel & Guy 2007; Tzuriel & Caspi 2010; Tzuriel & Shamir, 2007, 2010) following Tzuriel's studies about the effects of mother-child MLE strategies on children's cognitive modifiability (i.e. Tzuriel 1999, 2001). The PMYC program is *a process-oriented* program designed to teach children *how* to mediate effectively irrespective of the mediated content. The PMYC has three main objectives: (a) to enhance a *mediating teaching style* and (b) cognitive modifiability of tutors, and (c) to facilitate performance and learning skills of young children who are mediated by their experienced tutor peers. The principal assumption is that teaching for peer-mediation will both elicit better mediating skills from the tutors and improve cognitive skills in both tutees and tutors. The mediation skills acquired and internalized as a result of the intervention will enable children to apply them in future learning contexts, whether when teaching peers or being exposed to new learning experiences.

The PMYC program is characterized by five main aspects: (a) it combines cognitive and emotional components, (b) it is focused on 'learning how to learn' strategies and meta-cognitive principles, (c) it transcends content domains and contexts of learning, (d) it determines clearly the mediator's status; the mediator's status is higher than the learner's status. The mediator, as

a more experienced person who has learned how to mediate, has an active-modifying role in the interaction and (e) the mediation procedures used are structured and theoretically guided, but contain also creative ways to promote inter-subjectivity (Newson & Newson, 1975). The PMYC has three classical components: *direct teaching*, *demonstration,* and *practice*. Direct teaching includes presentation and explanation of the basic mediated learning principles. Demonstration includes observation and discussion of a didactic movie. The movie demonstrates mediation processes using the mediated learning criteria and specific components (i.e., empathy, respect) for peer interaction in an actual learning event. Practicing of the mediated learning principles with peers is carried out using varied means such as multimedia programs, role-playing, and the use of tasks required for later teaching activities. The PMYC consists of seven lessons (with each lesson lasting for 1 hour) given over a period of 3 weeks. Each lesson includes presentation of a mediation principle, understanding its significance in general and particularly in a peer-mediation situation, and practicing and applying the principles in varied learning situations. The program also includes didactic videotape demonstrations aimed at enhancing internalization of mediation principles, and learning aids (i.e., computer programs, games, posters, stickers with the visual symbols of the principles, and work sheets).

The effects of the PMYC on MLE strategies were reported in a series of studies (Shamir & Tzuriel, 2004; Shamir, Tzuriel, & Rozen, 2006; Shamir, Tzuriel & Guy 2007; Tzuriel & Trabelsi, 2014; Tzuriel & Caspi 2010; Tzuriel & Shamir, 2010). The findings show consistently that children participating in the PMYC program demonstrated higher level of MLE strategies than children in control groups who received a substitute program. In three studies, however, the effects of the PMYC were studied specifically in relation to cognitive modifiability, which is the focus of this paper (Tzuriel & Caspi 2010; Tzuriel & Shamir, 2007, 2010). For example, in Tzuriel and Shamir's (2007) study, Grade 3 mediators participating in the PMYC program (experimental group, n = 43) were compared to mediators in a control group (n = 46) who received a substitute program. Following the intervention stage, the experimental and control children participated in a peer-mediation condition, which was videotaped for 30 minutes. The mediators were instructed to assist their young counterparts in solving problems based on the operation of *seriation*. All mediators were administered at the end of the program: the Analogies Subtest from the *Cognitive Modifiability Battery* (CMB, Tzuriel 1995,

2000). The Analogies, administered by adult examiners, included Pre-teaching, teaching, and Post-teaching phases for each of the Analogies subscales: Testing and Transfer. The Pre-teaching score was taken as an indicator of the program's effect on solving problems and the Post-teaching score as the mediators' propensity to benefit from adult mediation and consequently improve their analogical performance. Repeated-measures analysis of variance of Treatment by Time (2 x 2) was carried out on each of the Analogies subscales. The findings showed significant interaction of Treatment by Time for the Transfer problems (i.e., more difficult). The interaction portrayed in Figure 5 indicates that the experimental group not only had higher Pre-teaching scores (given after the intervention program) but also showed higher Pre- to Post-teaching improvement than did the control group.

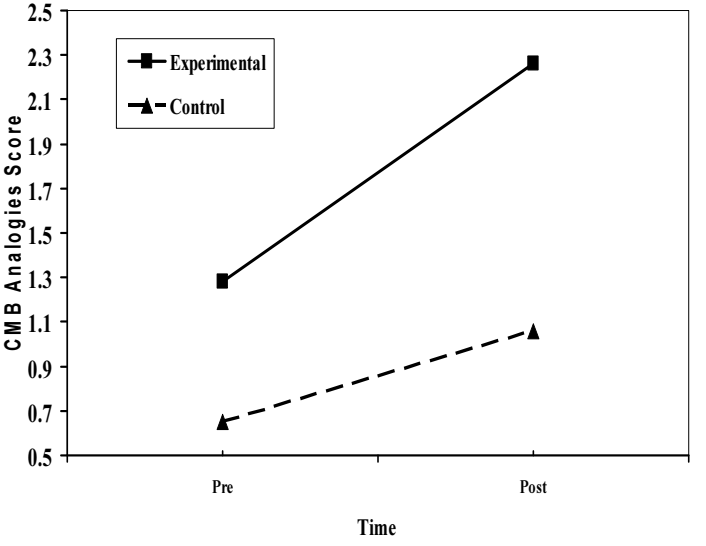


Figure 5. Pre- and Postteaching scores of mediators (Grade 3) on the Analogies Subtest of the *Cognitive Modifiability Battery*— (Transfer Problems) in the experimental and control groups (Copied by permission from *British Journal of Educational Psychology, 77*, 143-165).

This finding supports the expectation of higher cognitive modifiability in the experimental than in the control group. Group differences in the Pre- and Post-teaching phases of the analogies revealed that mediators in the experi-

mental group scored higher than did mediators in the control group in both the Pre-teaching, $t_{(84)} = 2.41$, $p < .05$, and Post-teaching, $t_{(84)} = 3.25$, $p < .01$, phases. These DA findings clearly indicate that mediators in the experimental group internalized the mediation principles and knew how to benefit from mediation given to them in a different context and consequently improved their performance higher than children in the control group. Thus, children who learn how to mediate become not only better mediators but also better learners, as reflected in their cognitive modifiability scores.

A more sophisticated question was asked in a study by Tzuriel and Caspi (2010) involving both mother-child and peers MLE processes. The question was does the PMYC program serve as a compensating factor for lack of mediation within the family? In the first phase of the study mother–child dyads (n = 100) were observed interacting in a structured teaching situation. The interaction was then analyzed by the *Observation for Mediation Interaction* (OMI) using five criteria of mediation. The children's sample was then divided into high- and low-mediation (of mothers) groups; each group was randomly assigned into experimental and control groups. The experimental group (n=49) received the PMYC program and the control group (n=51) received a substitute program. All children were then observed in peers teaching session where they were asked to teach their younger peers some analogy problems. The interaction was analyzed using the OMI, in the same way it was use when the children interacted with their mothers. In addition all mediators were administered a DA measure before and after the intervention: the *Analogies Subtest* from the *Cognitive Modifiability Battery* (CMB, Tzuriel, 1995). The The findings showed that children in the experimental group achieved higher cognitive modifiability in process oriented DA measure, as indicated by higher planning and self-regulation than in the control group. Children in the experimental group showed also higher performance on the CMB Analogies and on mediated learning strategies than children in the control group. As for the main question of this study an intriguing finding revealed that in the experimental group no significant differences were found between children of low- versus high-mediating mothers, $F_{(1,45)} = 1.63$, *ns*. The meaning of this finding is that the PMYC program could act as an "equalizing" factor between children of low-mediating mothers as compared with children of high-mediating mothers. A different pattern of findings was shown however in the control group. As expected, children of high-mediating mothers in the control group showed higher cognitive modifiability as com-

pared with children of low-mediating mothers, $F_{(1,47)} = 5.40$, $p < .05$, $\eta^2 = .10$. Simple main effects for each group of mothers' level of mediation (low *versus* high) showed that in the group of low-mediating mothers, cognitive modifiability of children in the experimental group was higher than cognitive modifiability of children in the control group, $F_{(1,45)} = 8.79$, $p < .01$, $\eta^2 = .16$. In the group of high-mediating mothers, on the other hand, no significant differences were found between the experimental and control groups, $F_{(1,47)} = .23$, *ns*. These findings support the idea that a program for peer mediation can serve as a compensating factor in families where children are not given opportunities for qualitative mediation.

The effectiveness of the peer mediation was investigated recently (Trabelsi & Tzuriel, 2014b) with a sample of adolescent students with severe learning disabilities (n = 110). The main objective of this study was to examine the differential and combined effects of two programs: The *Peer Mediation with Children-Math* (PMC-Math; Tzuriel & Trabelsi, 2014b) *and The Seria-Think* Program (STP, Tzuriel & Trabelsi, 2014a). The effectiveness of these programs was studied in four domains: (a) self-regulation and planning, (b) mediated learning strategies, (c) math discourse and (d) math performance. Half of the students who were in 9th Grade were assigned the role of mediators (n = 55) and half (n = 55) who were students in 7th Grade were assigned the role of learners. The intervention included two components: PMC-Math (A) and STP (B). Mediators were assigned randomly to one of four subgroups based on a Salomon-type design (2 x 2) and received the following components: Group 1- A+B, Group 2- A, Group 3- B, Group 4- none. The PMC-Math was composed of 7 sessions of learning the basic mediated learning experience strategies and the STP was composed of 5 sessions of learning the how to use the Seria-Think Instrument. All participants were administered the following tests before and after the intervention: Complex Figure Test, Matching Familiar Figure Test (MFFT), Seria-Think Instrument, Mazes (WISC-R), Math Exam. Following the intervention each mediator in 9th grade was assigned randomly to a learner from 7th grade and asked to teach how to solve the Seria-Think problems. The teaching (mediation) session was videotaped for 20 minutes and analyzed later by the *Observation of Mediation Interaction* (OMI) for the first five strategies of MLE. The results indicated (a) significant higher pre- to post-intervention improvement of Group 1 over the other three groups in all outcome variables, (b) Groups 2 and 3 showed higher improvements than the control group, and (c) Group 3 who received only the

STP showed better improvements than Group 2 who received the PMC-Math. Group 1 showed the highest mediation strategies followed by Groups 2 and 3 (equal), and Group 4. The importance of this study is in the theoretical and practical understanding of teaching and learning methodologies for development of self-regulation skills of students with learning disability in special education settings.

In Vygotsky's (1978) terms, the peer-mediation experience enabled the mediators to advance from a *lower* zone of proximal development (pre-intervention) to an *upper* zone of proximal development (post-intervention). Later studies by Tzuriel and Shamir (2010) and Tzuriel and Caspi (2010) consistently support the earlier studies showing positive effects of participation in the PMYC on cognitive modifiability.

Discussion and Conclusions

The studies reported above verify commonsense knowledge and theoretical conceptualization about the role of MLE processes in enhancing cognitive modifiability. MLE strategies, exemplified in the spontaneous family interactions, seems to affect the child's ability to benefit from mediation offered within the family context and to generalize to other formal and non-formal situations. One of the intriguing findings consistently emerging in most studies is that mediation for Transcendence (expanding) is the most powerful strategy predicting cognitive modifiability. This strategy has emerged as most powerful in predicting cognitive modifiability in spite of the fact that it was also found as the least frequent strategy and therefore with a limited score range. Mediation for Transcendence reflects the mediator's efforts to modify the abstract abilities of the child and to focus the child on concepts, generalizations, and principles. The DA measures used in all studies reflect also the ability of the child to solve problems requiring abstract concepts and rules.

The findings that distal factors in samples of children with learning difficulties (Bettan & Tzuriel, 2010; Tzuriel & Shomron, 2007) directly predict cognitive modifiability might indicate a need to modify or refine the MLE theory, at least for children with learning difficulties. In typically developing children, distal factors seem *not* to affect directly cognitive modifiability as suggested by the theory; they do affect, however, the MLE processes, which in turn affect cognitive modifiability. In samples of children experiencing se-

vere learning difficulties, the distal factors (adverse conditions) affect directly learning processes and cognitive modifiability. In order to cancel or overcome the adverse conditions effects, much more "robust" mediation efforts should be applied than the usual ones given within the typical parent-child interaction.

The refinement of MLE theory is related to the need to extend the concept of MLE to a more complex transactional-ecological model, taking into account the reciprocal nature of MLE and cognition as well as treating MLE as one component within a holistic framework. This is especially important because of the danger of overextending the presumed influence of MLE and attributing overly many cognitive and non-cognitive effects to MLE. Overgeneralization of MLE theory to explain too many phenomena may bring about only the devaluation of the theory. It is most important now that the effects of MLE are established so as to delineate the conceptual limits of the theory. The term “transactional” rather than “interactional” is meant to emphasize the idea of the mutual effects of MLE and cognitive functioning. Wachs and Plomin (1991) defined interaction as involving different individuals differentially reacting to similar environments, whereas transaction implies effects that are differential both for individuals and environments. Tzuriel (1991) conceptualized interaction as characterized by relative simplicity and transience of effects, whereas the transactional process is dialectically *circular* with a continual change and adjustment of factors. This dialectical circularity poses a real challenge for theory development and methodology, but with recent advances in technology and statistical analyses it can be handled efficiently. We should be aware that there is a possibility that the children's cognitive functioning might influence parental MLE strategies, and that the circular relation depends on broader family, social, and cultural contexts. Similar conceptions have been discussed in Bronfenbrenner’s (1979) ecological approach and by Super and Harkness (1986), who proposed also the concept of *developmental niches*. Some evidence for the effects of age, context, and severity of a child’s problems, and cultural background has been reported as well (e.g., Klein, 1988; Klein & Aloni, 1993; Tzuriel & Weiss, 1998; Tzuriel & Weitz, 1998; Tzuriel & Eran, 1990). The affective and motivational processes of children and their parents are also very important as prerequisite factors in determining the nature of MLE processes, children's cognitive modifiability, and the nature of their reciprocal effects.

The findings of peer-mediation studies indicate clearly that children in experimental groups participating in the PMYC program showed better mediational teaching style. Recent studies demonstrate that a program for peer mediation can compensate for low level of mediation in the family (Tzuriel & Caspi (2010) and serves as a powerful facilitation of self-regulation and planning of children with severe learning disability (Tzuriel & Trabelsi, 2014a; Trabelsi & Tzuriel, 2014).

An important implication of these studies is that children's MLE strategies could qualitatively and quantitatively be improved beyond the spontaneous developmental process of mediation skills. The enhancement of mediation skills was demonstrated not only with children who participated in the PYMC program, but also was transferred to children who were taught by their qualified peers. The use of the MLE criteria allows us not only to design intervention for peer-mediation, but also to describe the nature of the mediating behaviors used by children during social interactions such as peer learning or play.

The significant findings on the effects of the PMYC program on cognitive modifiability of mediators (Shamir et al., 2006; Shamir, Tzuriel, & Guy, 2007; Tzuriel & Shamir, 2007, 2010; Tzuriel & Caspi, 2010) support our expectations that children who learn how to mediate become not only better mediators (tutors) but also better learners, as reflected in their pre- to post-teaching improvement on various DA measures (see Figure 4). In Vygotsky's (1978) terms, the peer-mediation experience enabled the tutors to advance from a *lower* zone of proximal development to an *upper* zone of proximal development. It should be noted that the problems of the CMB Analogies were novel to all children, so the improvement cannot be attributed to a familiarity factor. Furthermore, the PMYC program does not contain any components that are similar to the tasks used to assess the mediators' cognitive modifiability. The significance of the greater gains of children in the experimental groups should be evaluated in relation to two facts; first, that the administered tests tap a different cognitive skill than those taught in the program, and second, that the standardized tests in most studies failed to reveal the effectiveness of the program. Application of DA as a central evaluation method reveals that the contribution of the cognitive education program was not simply supporting the development of a particular skill practiced during the program; it also involved teaching children *how to benefit from mediation* in a different set-

ting and consequently improve their cognitive performance across other domains.

In further research it will be important to investigate the contribution of the PMYC program or programs developed for enhancement of parents' mediation style as compensatory programs with children coming from low mediating families. It is conceptually important to establish the relative effects of cognitive education programs aimed at developing children's and parents' mediation skills on the children's cognitive modifiability. Development of mediation programs is especially important for parents of children experiencing learning difficulties or parents who, for a variety of reasons lack mediation skills. Further research is also required to study the effects of mediating agents such as siblings, grandparents, and teachers on children's cognitive level.

References

Belsky, J., Goode, M.K., & Most, R.K. (1980). Maternal stimulation and infant exploratory competence: Cross-sectional, correlational, and experimental analyses. *Child Development*, *51*, 1168-1178.

Berk, L.E. & Spuhl, S.T. (1995). Maternal interaction, private speech, and task performance in preschool children. *Early Childhood Research Quarterly*, *10*, 145-169.

Bornstein, M., H. & Tamis-LeMonda, C. (1990). Activities and interactions of mothers and their first-born infants in the first six months of life. *Child Development*, *61*, 1206-1217.

Bradley, R.H., & Caldwell, B.M. (1984). *Home Observation for Measurement of the Environment*, (HOME) (rev. ed.). Little Rock, AK: University of Arkansas.

Bronfenbrenner, U. (1979). *The ecology of human development.* Cambridge, MA: Harvard University Press.

Cristofaro, T.N. & Tamis-LeMonda, C.S. (2012). Mother-child conversations at 36 months and at pre-kindergarten: Relations to children's school readiness, *Journal of Early Childhood Literacy,* 12, 68-97.

Embretson, S.E. (1992). Measuring and validating cognitive modifiability as ability: A study in the spatial domain. *Journal of Educational Measurement, 29*, 25-50.

Feuerstein R. & Feuerstein S. (1991). Mediated learning experience: A theoretical review. In R. Feuerstein, P.S. Klein, & A. Tannenbaum (Eds.). *Mediated Learning Experience* (MLE) (pp. 3-52). London: Freund.

Feuerstein, R., Feuerstein, R. S., Falik, L. H., & Rand, Y. (2002). *The dynamic assessment of cognitive modifiability: The Learning Propensity Assessment Device, Theory, instruments, and techniques.* Jerusalem: ICELP Press.

Feuerstein, R., Rand, Y. & Hoffman, M.B. (1979). *The dynamic assessment of retarded performers.* Baltimore: University Park Press.

Feuerstein, R., Rand, Y., Hoffman, M. B., & Miller, R. (1980). Instrumental Enrichment. Baltimore, MD: University Park Press.

Greenberg, K. H. (1990). Mediated learning in the classroom. *International Journal of Cognitive Education and Mediated Learning, 1*, 33-44.

Haywood, H. C., Brooks, P. H., & Burns, M. S. (1986). Stimulating cognitive development at developmental level: A tested, non-remedial preschool curriculum for preschoolers and older retarded children. In M. Schwebel & C. A. Maher (Eds.), *Facilitating cognitive development: Principles, practices, and programs* (pp. 127-147). New York: Haworth Press.

Haywood, H. C., Brooks, P. H., & Burns, M. S. (1992). Bright Start: Cognitive curriculum for young children. Watertown, MA: Charlesbridge.

Haywood, H. C., & Lidz, C. S. (2007). *Dynamic assessment in practice: Clinical and educational applications*. New York: Cambridge University Press.

Haywood, H. C., & Tzuriel, D. (Eds.). (1992). *Interactive assessment*. New York: Springer-Verlag.

Klein, P. S. (1988). Stability and change in interaction of Israeli mothers and infants. *Infant Behavior and Development, 11*, 55-70.

Klein, P. S. (1991). Improving the quality of parental interaction with very low birth weight children: A longitudinal study using a mediated learning experience model. *Infant Mental Health, 12*, 321-337.

Klein, P. S. (Ed.). (1996). *Early intervention: Cross cultural experiences with a mediational approach*. New York: Garland.

Klein, P. S., & Aloni, S. (1993). Immediate and sustained effects of maternal mediation behaviors on young children. *Journal of Early Intervention, 17*, 1-17.

Klein, P. S., Weider, S., & Greenspan, S.I. (1987). A theoretical overview and empirical study of mediated learning experience: Prediction of preschool performance from mother-infant interaction patterns. *Infant Mental Health Journal, 8*, 110-129.

Klein, P.S., Zarur, S., & Feldman, R. (2002). Mediation in a sibling context: The relations of older siblings mediating behaviour and younger siblings task performance. *Infant and Child Development, 11,* 321-333.

Laosa, L. M. (1980b). Maternal teaching strategies in Chicano and Anglo-American families: The influence of culture and education on maternal behavior. C*hild Development, 51,* 759–765.

Lidz, C.S. (1991). *Practitioners' guide to dynamic assessment*. New York: Guilford Press.

Lidz, C. S. & Elliott, J. G. (Eds.) (2000). Advances in cognition and educational practice. *Dynamic assessment: Prevailing models and applications*. Oxford: Elsevier.

Newson, J. & Newson, E. (1975). Intersubjectivity and the transmission of culture: On the social origins of symbolic functioning. *Bulletin of the British Psychological Society*, *28*, 437-446.

Parker, F.L., Boak, A.Y., Griffin, K.W., Ripple, C. & Peay, L. (1999). Parent-child relationship, home learning environment, and school readiness. *School Psychology Review*, 28, 413-425.

Ramey, C.T., Farran, D.C., & Campbell, F.A. (1979). Predicting IQ from mother-infant interactions. *Child Development*, *50*, 804-814.

Raven, J. C. (1956). *Guide to using the Colored Progressive Matrices, Sets A, Ab, and B*. London: Lewis.

Remer, R. & Tzuriel, D. (July 2011). The effects of intervention using puppets with kindergarten learning disabled children on teachers mediated learning strategies and children's motivation and emergent literacy. Paper presented at the 11th conference of the International Association for Cognitive Education and Psychology, Boston MA, USA.

Rodriguez E.T., et al., (2009). The formative role of home literacy experiences across the first three years of life in children from low-income families. *Journal of Applied Developmental Psychology*, *30*, 677–94.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development and social context*. London: Oxford University Press.

Shamir, A., & Tzuriel, D. (2004). Children's mediational teaching style as a function of intervention for cross-age peer-mediation. *School Psychology International*, *25*, 58-97.

Shamir, A., Tzuriel, D. & Guy, R. (2007). Computer-supported collaborative learning: Cognitive effects of a peer mediation intervention. *Journal of Cognitive Education and Psychology, 6,* 373-394.

Sroufe, L.A. & Waters, E. (1977). Attachment as an organizational construct. *Child Development, 48*, 1184-1199.

Super, C., & Harkness, S. (1986). The developmental niche: A conceptualization at the interface of society and the individual. *International Journal of Behavioral Development*, *9*, 545-570.

Tamis-LeMonda, C.S., Bornstein, M.H., & Baumwell, L. (2001) Maternal responsiveness and children's achievement of language milestones. *Child Development*, *72*, 748-67.

Trabelsi, G. & Tzuriel, D. (April 2014). The Influence of peer mediation with children (PMC) program on executive functions, mathematical performance and discourse, and mediated learning strategies, among adolescents with learning disabilities. Paper presented at the international conference of To see Beyond Disability: YAI, New York.

Tzuriel, D. (1992). *The Children's Inferential Thinking Modifiability (CITM) test - Instruction Manual.* School of Education, Bar Ilan University.

Tzuriel, D. (1995). *The Cognitive Modifiability Battery (CMB): Assessment and Intervention – Instruction Manual*. School of Education. Bar Ilan University.

Tzuriel, D. (1996). Mother-child mediated learning strategies in free-play and structured situations among low, medium, and high-SES levels. *Child Development and Care, 126*, 57-82.

Tzuriel, D. (1997). A novel dynamic assessment approach for young Children: Major dimensions and current research. *Educational and Child Psychology, 14,* 83-108.

Tzuriel, D. (1999). Parent-child mediated learning transactions as determinants of cognitive modifiability: Recent research and future directions, *Genetic, Social, and General Psychology Monographs, 125*, 109-156.

Tzuriel, D. (2000a). Dynamic assessment of young children: Educational and intervention perspectives. *Educational Psychology Review, 12,* 385-435.

Tzuriel, D. (2000b). The Cognitive Modifiability Battery: Assessment and Intervention. In C.S. Lidz & J. Elliott (Eds.) *Dynamic Assessment: Prevailing models and* applications (pp. 375-406). New York: Elsevier Science.

Tzuriel, D. (2001). *Dynamic assessment of young children*. New York: Kluwer Academic/Plenum Press.

Tzuriel, D. (2002). Dynamic assessment of learning potential. *Encyclopedia of Education (2nd ed.)* J.W. Guthrie (Ed.), *(pp. 127-131)*. New York: McMillan Press.

Tzuriel, D. (2011a). Mediated learning and cognitive modifiability. *Encyclopedia of Sciences of Learning*. N.M. Seel (Ed.) (pp. 2154-2157). New York: Springer Publishing.

Tzuriel, D. (2011b). Mediators of learning. *Encyclopedia of Sciences of Learning*. (pp. 2157-2161). N.M. Seel (Ed.) New York: Springer Publishing.

Tzuriel, D. (2013). Mediated learning experience strategies and cognitive modifiability. *Journal of Cognitive Education and Psychology, 13,* 59-80.

Tzuriel, D. & Eran, Z. (1990). Inferential cognitive modifiability of Kibbutz young children as a function of mother-child mediated learning experience (MLE) interactions. *International Journal of Cognitive Education and Mediated Learning, 1,* 103-117.

Tzuriel, D. & Eiboshitz, Y. (1992). A Structured program for visual motor integration (SP-VMI) for preschool children. *Learning and Individual Differences*, *4*, 103-124.

Tzuriel, D. & Ernst, D. (1990). Cognitive modifiability of young children and mother-child mediated learning experience (MLE) interaction in low medium- and high-SES. *International Journal of Cognitive Education and Mediated Learning, 1*, 119-135.

Tzuriel, D. & George, T. (2009). Improvement of analogical reasoning and academic achievements by the Analogical Reasoning Program (ARP). *Educational and Child Psychology*, *29*, 71-93.

Tzuriel, D. & Gross, A. (February 1992). Achievements in Talmud as a function of teacher's mediational strategies and attitudes towards cognitive modifiability, and students' intellectual skills and motivational orientation. Paper presented at the Third International Conference on Cognitive Education: Models of Cognitive Instruction of the International Association for Cognitive Education. Riverside, CA, USA.

Tzuriel, D. & Hanuka-Levy, D. (2014). Siblings' mediated learning strategies in families with and without children with intellectual disabilities. *American Journal of Intellectual Disability and Disorders, 119, 565-588.* DOI: 10.1352/1944-7558-119.6.565

Tzuriel, D., & Hatzir, A. (1999). *The effects of mediational strategies of mothers and fathers and amount of time they spent with their young children on children's cognitive modifiability*. Unpublished manuscript, School of Education, Bar-Ilan University, Ramat Gan, Israel.

Tzuriel, D., Kaniel, S., Kanner, E., & Haywood, H.C. (1999). The effectiveness of Bright Start program in kindergarten on transfer abilities and academic achievements. *Early Childhood Research Quarterly, 114*, 111-141.

Tzuriel, D., Kaniel, S., & Yehudai, M. (1994, July). *Mediated learning experience (MLE) interactions among Etheopian immigrant and Israeli-born mothers.* Paper presented at 12th International Congress of the International Association for Cross-Cultural Psychology, Pamplona, Spain.

Tzuriel, D., Kaniel, S., Zeliger, M., & Friedman, A., & Haywood, H.C. (1998) Effects of the Bright Start program in kindergarten on use of mediated learning strategies and children's cognitive modifiability, *Child Development and Care, 143,* 1-20.

Tzuriel, D., & Klein, P. S. (1985). Analogical thinking modifiability in disadvantaged, regular, special education and mentally retarded children. *Journal of Abnormal Child Psychology*, *13*, 539-552.

Tzuriel, D. & Shamir, A. (2007). The effects of peer mediation with young children (PMYC) on children's cognitive modifiability. *British Journal of Educational Psychology*, *77*, 143-165.

Tzuriel, D. & Shamir, A. (2010). Mediation strategies and cognitive modifiability in young children as a function of peer mediation with young children (PMYC) program and training in analogies versus math tasks. *Journal of Cognitive Psychology and Education, 9,* 48-72.

Tzuriel, D. & Shomron, V. (July, 2009). Cognitive modifiability and psychological resilience: The effects of mother-child mediated learning experience (MLE) and home supportiveness among learning disabled children. Paper presented at the 12th International Conference of the International Association for Cognitive Education and Psychology (IACEP), University of Osnabrück, Germany.

Tzuriel, D. & Rokach, G. (July, 2009). Sibling's mediated learning strategies in Jewish families with many versus few children: The relation to home support and religious orientation and their effects on cognitive modifiability. Paper presented at the 12th International Conference of the International Association for Cognitive Education and Psychology (IACEP), University of Osnabrŭck, Germany.

Tzuriel, D. & Trabelsi, G. (2014a). The effects of the Seria-Think Program (STP) on planning, self-regulation and math achievements among Grade 3 Children with Attention Deficit Hyperactivity Disorder (ADHD). In Papadopoulos, T. C., Parrila, R. K., & Kirby, J. R. (Eds.). *Cognition, intelligence, and achievement: A tribute to J. P. Das.* San Diego, CA: Academic Press.

Tzuriel, D. & Trabelsi, G. (2014b). *The Peer Mediation with Children – Math.* School of Education, Bar Ilan University, Ramat-Gan Israel.

Tzuriel, D. & Weiss, S. (1998). The effects of mothers' acceptance/rejection attitudes, children's personality and mothers' mediated learning strategies on cognitive modifiability. *Early Development and Parenting, 7*, 79-99.

Tzuriel, D. & Weitz, A. (1998). Cognitive modifiability as a function of mother-child mediated learning strategies among very low birth weight and normally born children. Unpublished manuscript, School of Education, Bar-Ilan University, Ramat Gan, Israel.

Valsiner, J. (1988). *Developmental psychology in the Soviet Union.* Brighten: Harvester.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Vygotsky, L. (1986). *Thought and language*. Cambridge, MA: The MIT Press.Wachs, T. D. (1992). *The nature of nurture*. Newbury Park, CA: Sage.

Wachs, T. D. & Plomin, R. (1991). *Conceptualization and measurement of organism-environment interaction.* Washington, DC: American Psychological Association.

Weitz, A. & Tzuriel, D. (July, 2007). The Relationship between mediated learning strategies in mother-child interactions and personality, behavior, temperament, and cognitive skills of 8—9:6 year old children born with very low birth weight. Paper presented at the 11th International Conference of the International Association for Cognitive Education and Psychology (IACEP), University of Tennessee, Knoxville, TN, USA.

Wertsch, J. V. (1985). *Culture, communication and cognition: Vygotskian perspectives.* London: Cambridge University Press.

Wood, D. J., Bruner, J., & Ross, G., (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*, 89-100.

Modifiability and mediated learning in the light of neuroscientific evidence of ecological plasticity

JO LEBEER [1]

Abstract

This article explores the concept of ecological plasticity in relation to cognitive modifiability and mediated learning. Although direct neuroimaging evidence on the effect of Mediated Learning Experience is lacking up till now, there is some indirect evidence. The brain's development is not finished at birth, but cognitive development is contingent on the development of multiple brain networks. The brain is shaped by experience. The development of mind results from constant building of new synaptic connections as a result of learning activities, generated by a complex puzzle of stimuli: interaction with people, inclusive environments (home, school, leisure,), intervention programmes, socio-emotional experience, and mediated learning experience. Current evidence is reviewed how "environmental enrichment", a well-studied phenomenon from animal studies, can be transferred to human beings. Ecological plasticity is a characteristic of brain development : ecology has "external " as well as "inner" factors, whereby "external" means the whole of the stimuli a person receives from the outside world (information, activities) triggering emotional and learning experiences, whereas by "inner" factors we mean conscious and unconscious experiences. We criticize reductionist and deterministic discourse in much of the literature on brain and behaviour connection. Ecological neuroplasticity thus can be regarded as the neurobiological basis of Structural Cognitive Modifiability theory, which was anticipated by Reuven Feuerstein 50 years ahead of his time. However, at present, no distinction on neuroimaging can yet be made between mere activation and human-mediated activation. The specific action of mediated learning on neurobiological reorganisation of plasticity remains as yet to be researched.

Keywords

cognitive modifiability, ecological neuroplasticity, developmental disability, mediated learning experience

1. MD PhD, Universtiy of Antwerp, Belgium. Faculty of Medicine & Health Sciences, Department of Primary and Interdisciplinary Care, Disability Studies. jo.lebeer@uantwerpen.be

Introduction

Modifiability is defined as the capacity of the human being to become durably modified by elaborating stimuli, so as to become able to adapt to new and changing situations. Feuerstein's Structural Cognitive Modifiability (SCM) theory (Feuerstein ea., 1979) states that a human being's cognitive development is generated by mediated learning experiences (MLE), gradually accumulated during life by cultural transmission from parents, teachers or other significant people in a child's life. Feuerstein postulated that all human individuals are modifiable, despite brain or genetic damage, or other causes which impair functioning. This postulate is based on extensive clinical data with a variety of individuals with various kinds and aetiologies of neurological impairments (Feuerstein, 2006). In this article we will explore the neurobiological basis of modifiability and mediated learning within a conceptual framework of the ecology of development, more specifically regarding the development of mind.

Donald Hebb (1949) anticipated that all learning must have structural consequences in brain organisation. Countless research studies about what has become known as neuronal plasticity, have confirmed Hebb's thesis. With the availability of neuroimaging technology at the end of the 20th century, knowledge about brain functioning and structural plasticity in human beings has been exponentially growing.

Examples of modifiability despite brain impairments

In our clinical work we have come across about 700 children and adults with some form of neurological impairment (brain injury, autism, genetically based syndromes, intellectual impairment, learning disabilities, etc.), who showed various degrees of modifiability, relative to the kind and degree of brain functioning impairment. It is important to distinguish *modifiability* from *normality*. There is no such as thing as a normal child, writes Roberta Garbo (2009; 18): "To recognize a new image of the norm, is a key to a cognitive restructuring of society, which is needed to adopt a mature vision to real inclusion"

Though all cases are remarkable, the following three examples are particularly illustrative of modifiability despite neurological impairments.

Peetjie Engels, now a young woman with Down syndrome, was in special education until the age of 9, where her educational programme was a low profile, with little attempts at teaching reading or writing, because in the eighties of the 20th century, it was considered either impossible or "not needed" to teach children with Down syndrome literacy or numeracy. At the age of 9 she switched to regular education. With the help of many people, in the first place her parents, the school team, sister, friends, and a thinking skills' programme (Feuerstein's Instrumental Enrichment), she reached a hitherto unknown level of cognitive development. She obtained a high school degree, a scooter's driver's licence and she lives an independent life. She describes her life as "a nice life" and stresses the need to work actively with children with Down syndrome from a young age and send them to regular schools (Engels, 2006). There are no indications that Peetjie is a mosaic trisomy 21, which is often advocated in the case of people with Down syndrome with unusual high degree of cognitive development. There are many other examples of people with Down syndrome who have attained high levels of cognitive development, which were unthinkable in the sixties. Although academic as well as general cognitive development is not always so spectacular, the case of Peetjie and others demonstrates that modifiability is a reality and a possibility. Interestingly, she was not an exceptional case "in the beginning". We are only beginning to understand the complex processes which lead to higher cognitive development.

Another example is Michael, who was a normally developing child until he was operated for a brain tumour (microcellular astrocytoma) at 4 years of age and a second time at the age of 8. While epilepsy and behaviour disturbance greatly improved after brain surgery, he remained with a huge frontotemporal brain damage (figure 1), leaving him with a spastic left hemiplegia, serious cognitive difficulties, wheelchair-bound and reading and writing difficulties. Thanks to committed parents, therapists and teachers, he relearned to walk again, to read and to write and finished middle school with reasonable success, having delays in certain topics such as math, language and sciences. At the age of 15, he still had substantial deficits in verbal as well as performance components of intelligence, in abstract thinking and problem resolution, with a WISC-R score of 49. Contrary to the advice to go to a school for manual executive labour, his parents and therapist were not ready to accept these low expectations. An evaluation with Feuerstein's LPAD battery (Lebeer, 2005) gave a different perspective and indicated a high capacity for ab-

stract thinking, no inherent memory defect, but a deficit in memorization and retrieval for lack of strategies, which could be resolved by teaching him better ways to organize. With the help of an intensive school- and family-oriented coaching program, inclusive education, cooperation with teachers, individual coaching by a rehabilitation team and a cognitive education program, he finished a scientific high school with success and was able to study at university. His IQ had risen to 95 in 4 years' time.

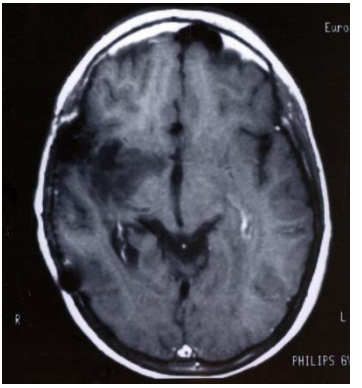


Figure 1. Michael, post-operative MRI showing extensive right frontotemporal cortical damage

A third example is Alex, a boy who was born with Sturge-Weber disease and unilateral multiple epileptic foci. Until the age of 9 years, he did not develop any speech, his language understanding remained at a low level; he was also behaviourally disturbed and functioned on a low cognitive level in the IQ range of 40-50. Because no combination of drug therapy was able to stop his epileptic spells, he was operated with a hemispherectomy at the age of 9 years. Despite a bad prognosis regarding speech development, because the assumed critical period of language development had been passed, he started to speak after the brain surgery (Vargha-Khadem e.a., 1997). His mother was intensively involved in his rehabilitation process. Though becoming quite fluent in speaking, he remained with a right sided hemiplegia. He had some difficulties in walking and fine motor coordination as well as serious learning and social difficulties. Despite attempts to teach him to read, write and to calculate, he was in a special school until the age of 16 making little

progress in academic skills. Alex became a resident pupil at the International Centre for the Enhancement of Learning Potential in Jerusalem (ICELP), where he was given more opportunities and challenges in academic and social learning. With intensive investment in mediated learning, described in detail by Sharma (2002), he made remarkable progress. He went to a regular school and he obtained a diploma in business administration in a vocational programme in a special school. At the age of 33, he is cheerful very social young man, managing his own life (with some assistance) and volunteers for the Red Cross, having been unable to find a paid job.

Several other examples of modifiability despite extreme brain lesions have been described earlier (Lebeer, 1998). Children with very extensive damage to the cortex recover fairly well or completely in some cases: e.g. in hydrocephalus (Smith & Sugar, 1984; Bigler, 1995); porencephalic cysts (Zhang & Sheng-Yu, 1984; Blackman, 1991) or absence of the small brain or Dandy-Walker syndrome (Maria e.a., 1987). Also in hemispherectomy, where an entire hemisphere is taken away, in 90 % of the cases epilepsy improves and sensorial and behavioural disturbances improve (Devlin e.a., 2003). Other authors have reported full recovery in adult hemispherectomized patients (Arnott, 1982; Damasio, 1975) as well as in children (Goodman & Whitaker, 1985). One of the most spectacular cases is a Hungarian 22-year old man, who was accidentally discovered to have extensive damage to his brain in both parts, which he must have had from birth. He had studied industrial engineering and had no symptoms at all (Leel-Ossy, 2006). Lorber described the case of a man with hydranencephaly (i.e. extreme hydrocephaly with absence of cortex), who was estimated to have only 5 % of brain cortex; yet this man studied mathematics on university level and was not aware of his brain damage until a scan was made at the age of 18 because of lasting headache (Lewin, 1980).

What might be a neurobiological basis of modifiability?

Brain plasticity after damage and in learning

The human body has an impressive healing capacity. Wounds close, blood clots, broken bones grow together again. A human being can survive with one quarter of a liver, with one quarter of only one of both kidneys, without spleen and only one lung. The whole continues to function in spite of dam-

age to its parts. Similarly the brain, its most complicated organ, has this capacity to adapt its structure and functioning, as a response to learning or to damage, although it does not seem to be as easy as restoration of other organs.

The brain never stops developing

At birth the brain is estimated to contain over a 100 billion neurones. Each neuron has hundreds of dendrites, receiving messages from other neurons, adjacent or far away, via the synapses. This gives innumerable connection possibilities. The construction of the brain during nine months of intrauterine growth is a very delicate process, in which many things can go wrong (. It is a miracle that the brain can function as a co-operative whole, starting off with only two cells (Eccles & Robinson, 1985).

The construction of the brain's hardware, is not terminated at birth. It continues to evolve into adulthood. There is much more than a simple growth in size, or in myelinisation. Synapses are continuously created and destroyed. Synaptic density peaks during the early years, until reaching a stable level at adult age (De Graaf-Peters & Hadders-Algra, 2006). There is programmed cell death, due to an excessive production during pregnancy, which continues after birth. The final network structure of the neuronal connections is established years after birth, not in the first place as an unfolding of a genetically determined structure, but it is *caused by experience* (Aoki & Siekevitz, 1988; Johnston, 2009). Activity drives synaptic plasticity and brain development. Functions that are not activated (motor, language, sensory, social, cognitive) will not lead to the creation of the proper brain structures. Neuronal group selection theory (Edelman, 1989) states that the brain is "shaped" through the process of developmental and experiential selection among the infinite connection possibilities.

This has enormous consequences for early intervention (Hadders-Algra, 2000). These relatively new findings support Feuerstein's mediated learning theory, which holds that experiences, mediated through human intervention, with a specific quality of interaction, are responsible for the creation of higher cognitive functions.

Natural healing system

As a reaction to damage, nerve axons grow out to make new connections. This phenomenon is called axonal sprouting and synaptic plasticity. The number of dendrites increases, as does the number of synapses (Klintsova & Greenough, 1999). It has long been believed that the number of neurones does not increase after birth, but many studies have shown that new neurones are formed after damage (Rakic, 2002). In human beings there is also evidence of synaptic reformation through dendrites: hemiplegic children have been found to develop compensatory non-crossing neuronal pathways on the affected side, provided they are actively stimulated (Farmer e.a., 1991; Carr, 1996).

There are also neuro-chemical changes. Denervation hypersensitivity, a phenomenon indicating that the post-synaptic plate becomes more sensitive to the stimuli of the neurotransmitters, is an example. Neurotransmitter production is increased (Marshall, 1985). Trophins, substances promoting nerve and axon growth, acutely regulate synaptic plasticity. Activity-driven experience activates specific gene promoters (BDNF –brain derived neurotrophic factor), leading to enhanced transcription, elevated trophin levels, postsynaptic receptor activation and increased synaptic transmission, constituting an epigenetic mechanism of gene expression (Black, 1999; Alder e.a., 2002). This might provide a major explanation of the mechanism of cognitive development, illustrated in the case examples above.

The same phenomena happen in the brain not only after damage, but also in learning. Each time we learn something new, the brain undergoes a structural change in its synapses. The synapses of the hippocampus react to learning situations with an increased long-term potentiating (LTP) effect: the synaptic plate, which receives the message, becomes more sensitive to chemical substances (Teyler & Fountain, 1987; Morris, Kandel & Squire, 1988; Squire, 2004).

Plasticity and activity: principles of experience-dependent neuroplasticity

There is overwhelming evidence, from animal studies as well as in human beings, that the development of the young brain as well as the reorganization of the brain, after damage or just in natural learning circumstances, is contingent on experience. This is called experience-dependent neural plasticity (Van Praag e.a., 2000).

Epigenetic influences

It is clear that the construction of the brain is influenced by genetic programming. But this is not enough. There are many instances where the natural capacity of neuronal networks to react and adapt are interrupted by a genetic defect. Rett syndrome is such an example, where it is believed that the gene MeCP2 hampers plasticity of early migration (Shabazian & Zhogbi, 2002). Similarly, in Fragile X syndrome – which is the most frequent cause of intellectual impairment in boys after Down syndrome, it has been shown that something is wrong in the "fingers" at the end of the synapses, which causes difficulties in the construction of the neuronal network. The neurochemical mechanisms, which lead the "stuttering" fragile-X gene to transcribe into a disturbed protein formation, are fairly well known. However, brains of animals with a Fragile-X-simulating condition, which are raised in active, enriched conditions, are more plastic (Ramakers, 2002). A similar mechanism applies in Huntington's disease (Nithianantharajah e.a., 2008). There is now evidence that not only genes drive the brain construction, but that activity and experience drive the gene expression mechanism. It looks as if Lamarck's first idea, that life experience may have genetic effects, is being rehabilitated.

Effect of age

Y*oung children* absorb rapidly enormous quantities of information and their capacity seems much higher than in adults: learning a second language, a musical instrument, reading and writing, skating and cycling all seem to work better. Children with frontal lesions, which in adults would certainly lead to

devastating symptoms, may have good outcome (Lebeer, 1998). Young children in whom the visual or acoustic areas of the brain are damaged recover quite well in most cases (Hécaen e.a., 1984). Hearing-impaired children who had an early cochlear implant, before the age of 1 year, have almost normal language development. When it's done later, there is a need for a much more intensive speech therapy, which is less successful (Geersa e.a., 2013). Children with hemispherectomy recover generally better than adults (Austin, 1955).

The plasticity of the brain to reorganise and take over functions from neighbouring areas seems to be better as long as the brain area is not too specialised. The immature brain compensates for neuronal injury better than the adult brain. However, cellular plasticity and nerve cell regeneration have been shown to exist in adult animals as well. Plasticity occurs over an entire lifetime (Kaplan, 1988).

Location and size

The degree of damage and subsequent recovery also depends on the location of the lesion. Small, scattered & asymmetric lesions are worse than symmetric lesions (such as compression in hydrocephalus or Dandy-Walker syndrome), but large unilateral lesions such as a porencephalic cyst may compensate well. Lesions in the brain cortex are better tolerated than deeper lying brain lesions. Whether there is a left- or right sided lesion also makes a difference: children where the left hemisphere had been removed had a normal language development (Smith & Sugar, 1975), apart from some syntax difficulties, and difficulties with understanding metaphoric language and reading. Children with right hemispherectomy had no problem at all. One of them obtained a university degree. This is also confirmed by a recent study in individuals with Sturge-Weber disease: those with small lesions as well as those with very large lesions have good cognitive outcomes, whereas those with intermediate lesions have worse cognitive development, which is suggestive of a mechanism of inhibition (Behen e.a., 2011)

Activity

Activity is of key importance in driving plasticity. Animals growing up together in stimulating environment have a better recovery and more plasticity. Rosenzweig & Bennet (1996) examined the difference in learning behaviour in brain damaged rats that were raised in standard conditions - an isolated position in a cage with just giving subsistence care - and others that were raised in an "enriched" environment - animals in a large cage with ample opportunity to exercise with various devices. Rats educated in *environmental enrichment* were better learners than those in isolation. Under conditions of environmental enrichment, neurone survival time increased, cortical thickness, neurone size, the size of the synaptic contact areas, neuronal metabolism, the number of synapses and the number of dendritic spines.

Not only in animals but also in human beings this has now been demonstrated. Maguire e.a. (2000) found that brain memory centres of *London taxi drivers* were thicker when the drivers had more experience and memorized street maps, than in the young ones with less experience and using navigation technology. Similarly, pianists' temporal lobe areas (related to auditory memory) have been shown to enlarge proportionally to the amount of time practised (Bangert & Altenmüller, 2003). Visual experience has been shown to have a profound effect on the maturation of the visual system in mammals, including humans (Kaplan, 1988).

It has been shown that cognitive activation and physical activity may compensate for function loss and even delay the onset of neurodegenerative diseases such as Alzheimer Disease, Parkinson and Huntington's disease (Hannan, 2014).

Deprivation and brain development

The opposite of activation is deprivation. Deprivation of sensory and motor stimuli has a negative effect on neurological development. Nobel Prize winners Hubel & Wiesel (1963) found that cats raised in a cylinder where they were exposed to diagonal patterns, were able to detect only diagonal patterns , and not vertical or horizontal - at adult age. When they grow up with one eye covered, the visual cortex that receives the information from the uncovered eye grows thicker to compensate. This finding is the basis of amblyopia treatment of covering the stronger eye in squinting children. This phenome-

non is similar to the effect of compensatory muscle growth in paralysis: unused potential atrophies (atrophy by lack of use). Deprivation of environmental stimulation occurs when young animals are separated from their mother. Examples of extreme environmental deprivation of stimuli in human beings, with lasting deleterious effects on intellectual, social and communicative development and only partial recovery, are some of the notorious cases such Victor, the wild boy of Aveyron (Malson & Itard, 1972), Genie (Skuse, 1984) and in the hospitalism and deprivation studies (Gunnar, 2001). On the other hand, the same stories also demonstrate the enormous plasticity despite early and long-lasting deprivation, when an intensive activation programme is set up (McVicker Hunt, 1986). In the semi-documentary "The Apple", Persian director Samira Makmalbaf relates the story of the Nadeeri twins, who had been locked up behind bars by their parents for fear of being abused. They could not speak, barely walked and were seriously cognitively retarded. Remarkably, by playing their own history in the movie, the twins started to talk and develop socially and cognitively.

Apparently there is a lot of plasticity possible even after the critical language period is over. Or perhaps the concept of "critical period" should be flexibilised. In summary: the brain grows by use, and it atrophies by deprivation. Use it or lose it.

Kleim & Jones (2008) summarize 10 principles of experience-dependent plasticity:

Table 1.
Principles of experience-dependent activity (after Kleim & Jones, 2008)

1. Use It or Lose It	Failure to drive specific brain functions can lead to functional degradation
2. Use It and Improve It	Training that drives a specific brain function can lead to an enhancement of that function
3. Specificity	The nature of the training experience dictates the nature of the plasticity
4. Repetition Matters	Induction of plasticity requires sufficient repetition
5. Intensity Matters	Induction of plasticity requires sufficient training intensity
6. Time Matters	Different forms of plasticity occur at different times during training.
7. Salience Matters	Training experience must be sufficiently salient/relevant
8. Age Matters	Training-induced plasticity easier in younger brains
9. Transference	Plasticity in response to one training experience can enhance the acquisition of similar behaviours, but it is not self-evident
10. Interference	Plasticity in response to one experience can interfere with the acquisition of other behaviours

It is not clear what kind of experience is needed to trigger brain development. Surely it is more complicated than just practice. What is meant in Kleim's summary of salient experience, time, intensity, repetition, and transference, can be found in Feuerstein's concept of "mediated learning experience". Feuerstein added a human element to the concept of "environmental enrichment" known from animal studies. This also includes a component of motivational-emotional activation, which we will discuss more in detail below.

Has every function its place in the brain?

Since Broca started to localize speech function in a specific temporal area of the brain, the brain has been mapped into detail. L*ocalisation theory* (Pribram, 1971) attributes specific functions to specific brain regions: Knowledge of this detailed localisation has been inferred from observations in patients who lack certain functions and appear to have defects in certain parts of the brain. With increasing resolution of the modern scanners, ever more defects are located. It is the basis of neuropsychology.

Pribram seriously criticizes the localization theory, however. In some cases there seems to be ample flexibility of localisation. Children's brain regions are not yet fully specialized and can change places. Memory seems to be distributed to large parts of the brain.

People with the occipital part of the brain lacking can learn to "see" with their parietal parts. Early –blind children learn to "read" Braille with their visual occipital cortex (Chen e.a., 2002). This means that the visual cortex which is specialized in visual recognition, can now decode sensory touch messages and translate them in a People with the occipital part lacking can learn to "see" with their parietal parts.

The speech centre which is usually on the left side, can go to the right side, but does so only after training, as is shown by PET scans of aphasic patients (Musso e.a. 1999). We described a girl with a left temporal porencephalic brain cyst with right-sided hemiplegia and normal speech). Despite serious cognitive problems (IQ 71), she was included in a mainstream school with an individualized programme and intensive parental support (Lebeer, 1998).

Cells of the temporal cortex, which normally "code" for auditory processing, can be trained to behave like visual cortical cells in recognizing patterns of orientation, when the visual cortex is damaged. In this experiment the brain had been rewired from the visual pathway to the auditory cortex, which led to specialisation of auditory cortex cells to recognize visual stimuli (Roe e.a. 1991; Merzenich, 2000). If it is possible to rewire the brain in experimental conditions, it can be imagined that similar mechanisms happen in natural situations.

Metaphors of brain functioning

It now becomes clear that the brain is a living system, constantly moving and recreating connections, with a capacity to learn and to react to damage with repair, subject to influences from outside and inside.

The compatibility of very large cortex lesions with a quasi-normal life, raises the fundamental question of *how much brain a mind needs* to function (Lebeer, 1998)? Apparently only 5%, which is far less than a chimpanzee. Certainly brain size is not related to intelligence, as is also demonstrated by Chugani's research on people with Sturge-Weber disease (Behen, 2011). But that raises another question: where does the brain store all this information, if 5% of cortex is left?

This calls for a different conceptualisation than the one commonly used as the brain as a sophisticated computer. A computer is prewired. Damage to its hardware is final; it is not self-repairing. Although sophisticated computers many times can perform operations much better than a man's brain, no artificial intelligence computer approaches the enormous capacity of plasticity of a human brain.

Looking at in vivo images of synapse formation in case of plasticity, one gets more the impression of the brain as a megalopolis: this is also a large complex whole consisting of many sub-entities, it is constantly moving, adapting, looking for better solutions and organization. It is constantly in evolution, with breakdown and rebuilding. It has a capacity to adapt to threats and damage and has lots of compensatory mechanisms. Yet, who is the mayor?

An ants' heap is also a better image, because ants' heaps are also capable of restoring damage, of communication via chemical substances, and a degree of self-reorganisation.

The brain is a very complex open system and as such has the properties of a "dissipative system" as described by Nobel Prize winner Ilya Prigogine (1984). Dissipative systems are in open connection with the world around (they absorb and give back energy). They have a capacity of self-organisation, of creating order out of chaos. According to Prigogine, open complex systems behave in an indeterministic way: one cannot predict whether there will be order or chaos. The brain apparently acts in a similar way.

Yet this does not answer the question where the information is stored when 90-95% of the cortex is absent, as in hydranencephaly. The old explana-

tion of *redundancy* (i.e. the idea that 90% of the brain is not used in normal conditions and constitutes a reserve) has been refuted since we know that after damage every brain region is immediately reused. The only plausible explanation can be found in Pribram's (1971) hypothesis of holographic storage, i.e. the brain is capable to store information in distributed wave interference patterns analogous to a holographic plate, which has the property to store information in a point-to-whole correspondence. That would mean that the memory storage in the brain is distributed (as Karl Lashley found) over the whole brain, and not contained in nerve cells (Speed e.a., 2010).

Metaphors of brain functioning have always existed and usually are based on current technological knowledge. Descartes e.g. had a mechanical metaphor of brain functioning: his theory proposed a complete separation of the brain as the material apparatus and the immaterial soul, known as the Cartesian worldview. Nowadays the most common metaphor of the brain is the computer. Metaphors, as cultural concepts, actually have an influence on creating culture as well. If one holds a computer-model of the brain, there is a tendency to view functioning still in a rather fixed way. Teachers, parents and health professionals, based on an unconscious metaphor of a "computer brain" will tend to think that "what is not there cannot be stimulated", when confronted with pupils with a damaged brain.

External and internal aspects in ecological plasticity

Analysis of remarkable developments, such as in our research and other published cases (Keller, 1903; Grandin, 1996, Feuerstein e.a. 1988), reveals a common pattern in their ecology. By "ecology" we mean the study of the relations between human beings and their environment (physical, psychological, social, information, etc.). A distinction can be made between external and internal aspects: e*xternal aspects* are *what* one does (stimuli, activities), *internal aspects* deal with *how* something is done on a level of experience (the energy level, e.g. enthusiasm, belief system). Our research has shown that the quality and quantity of active experiences is the most decisive in influencing outcome of children with neurological impairments *across* a variety of methods (Lebeer & Rijke, 2003). Children need to be actively stimulated, to be exposed to a rich variety of stimuli, to be mediated necessary steps leading to new functions by facilitating learning processes, to be provided new chal-

lenges and not stay in a status quo. There are many ways. The painter is more important than the paint he uses, in other words: it is *how* one interacts with the child which is the most important.

The way adults make intelligent use of their environment – in other words their ecology - substantially influences a child's intellectual, social and physical development. A simple decision e.g. to involve the child in its social environment rather than isolate it – which sadly is still often the case - to send it to a regular school, to go shopping, to play with animals, to visit places, etc. is a boost in experiences, leading to motivation, language, movement and social functions.

The environment *creates needs*, and it is the task of educators to take care that the child is sufficiently activated to give an answer to these needs. Peetjie's example mentioned above illustrates this: when she went to secondary school, the need rose to go by bicycle, as all children in the Netherlands do (the bicycle is part of the Dutch ecology). Her father (and Peetjie's luck to have such a father) taught her to ride a bike. He said it took him months to teach his daughter to cycle in traffic, to know where to stop, to look to the left and right to cross a street; to estimate the distances of the cars, to solve the complex traffic situations. That mediation lasted 3 months until Peetjie's sister urged him to let go, because she was convinced she could do it alone. We saw this kind of processes in many other children. Cycling is a motor as well as a cognitive process, with social learning components, because the need was generated by being in a normal school. Children attending a special school hardly ever get this experience, because they are taken by a special bus. A function only is generated when the opportunity in the environment is offered. Human caretakers take care that the child grasps the opportunities and accompany the learning processes. One needs to give the child sufficient learning opportunities. Children with special needs, whether they are in special schools or regular, often do not get sufficient opportunities to learn to read or write. First of all, it requires an environment where books are amply available, and where the need arises to learn to read; then sufficient mediation, a belief that they can learn it and the availability of a mediator.

Feuerstein's concept of an *Active Modifying Environment* (1988) describes four aspects which contribute to modifiability: (1) participation in everyday life and be exposed to a variety of experiences; (2) creating positive stress by causing disequilibrium; do not overprotect the child or keep it away from enriching experiences (3) offer challenging activities which provoke problem

solving and thinking and (4) offering adequate and adapted mediation. Placing an individual in a stimulating environment therefore is not enough. There is a difference between stimulation and mediation. One can overload children with stimuli, coming from television, electronic games, toys, voices, etc. This is not beneficial, because an overstimulated brain will also overreact, with e.g. ADHD or behavioural disturbance. The environment should be mediated, i.e. that the *stimuli should be adapted, selected and filtered* in such a way that the child is able to benefit from it in a structural, lasting way. How this can be done is explained elsewhere (Feuerstein, Klein & Tannenbaum, 1991). An example of language learning will make this clearer: one can live as a stranger in a foreign- language rich environment, yet not benefit from it for lack of an interpreter. This is the situation of children with Down syndrome in their own language environment, because they have an auditory perception and interpretation problem (Buckley, 2000). People in their environment should learn to speak clearly, slowly, in short and simple messages and with emphasis, so as to make sure that the child picks the message up and understands it. This can already make quite a difference in speeding up speech development. Visual support media such as using augmentative communication and later printed word might greatly enhance speech development.

Similarly, placing a child in a mainstream school (inclusive education) is a more enriching environment than a special school, but it is not necessarily more advantageous to the child, when no extra mediation is being offered by the people around the child, be it peers or adults. Only when inclusive education is accompanied by enhanced mediation, the child may really benefit (Lebeer, 2006).

Internal aspects are a decisive part of the human ecology and greatly influence modifiability. Inner experiences can be consciously aware or not. Feelings, emotions, awareness, motivation, will, experience of energy, vitality, drive, unity, love (or the opposites) operate primarily on an inner level (Rijke, 1993). They are hardly visible to inexperienced observers, but one can learn to observe them. Verbal declarations are unreliable. They are certainly inaccessible to questionnaires or superficial interviews asking opinions. Yet everyone knows that they are key to the more visible aspects of what one does. For example: it makes quite a difference to listen to a piece of music played by a skilled musician who plays "with heart and soul" or one who plays technically perfect but mechanically. Similarly, it makes quite a difference to work with a child who has motivation and energy, than to work with a

resistant child which does not really want. Or e.g. to work with a mediator using a programme such as Feuerstein's Instrumental Enrichment with or without "energy". The outcome will greatly depend on these inner factors, which are related to choice. On an inner level, even a small child chooses or not to engage in the interaction. In this way one can understand that sometimes children with autism may show high structural modifiability, while others are very difficult to modify. This is beautifully described by Temple Grandin, herself an individual with autism (Grandin, 1993).

These inner aspects render classic quantitative intervention studies highly problematic, because inner aspects are difficult to observe, to control and to manipulate and therefore are often dismissed as "placebo" effects. Yet they make all the difference between otherwise equal situations.

How the mind is built

The dominant paradigm in much of the scientific literature, as well as in medical-clinical practice and in school environments, still sees cognitive development as a property of the individual, given a more or less fixed capacity at birth, determined by genetic constitution, measurable by developmental tests and later intelligence tests (I.Q.). It is a basically linear-causal, maturational and mechanical model. However, more and more evidence becomes available, that the mind is not confined to the individual brain, but must be regarded in an ecological way. The idea of the "extended mind" has been forwarded by philosophers Andy Clark and David Chalmers (2010). It might help explaining why individuals with the same genetic damage such as trisomy 21 may display a wide variety in development. Mind is something what we do (Noë, 2009). The intellectual capacity of an individual is *not* a priori determined by genes or brain condition.

Ceci e.a. (1986) observed that some people, who otherwise carried a label of "mentally retarded" where capable of inventing highly complex solutions to predict better than others which horse was going to win the race at the horse race tracks. In other situations, however, such as in IQ tests, or in situations they did not have adequate experience, they were not nearly as efficient. The situation of complexity in their ecology, together with high motivation, helped them to develop complex operations. Ceci called this the con-

cept of *cognitive complexity*. Intellectual capacities to deal with cognitive complexity develop in circumstances of cognitive complexity.

The idea that the mind of a child, whether brain impaired or not, grows within the ecology in which the child lives, is compatible with the "embodied mind" theory (Varela & Maturana, 2000). Feuerstein's mediated learning experience theory added a specifically human component, in which the specific interaction between a mediator, the child, culture and the world, shapes the mind. Language acquisition plays herein a key role.

Affection triggers cognition

MLE theory however also has a strong *affective* component. The affective component is probably more important than anything in enabling brain functioning towards a development of higher cognitive functions (Cromwell & Panksepp, 2010). Typical babies intensely request communication with their mother. Trevarthen (1990) hypothesizes that this primary intersubjectivity is a condition for triggering gene expression and adequate neural development. In extremely deprived children absence of primary intersubjectivity hampers brain impairment. In children with congenital impairments, this affective intersubjectivity may be interrupted. When the baby does not smile back at the expected time, mothers may not exhibit the same patience to elicit a joyful mediational interaction (Mintzker, 1991). In Feuerstein's view this is also modifiable at any age. He stressed the importance of working with parents to restore the mediation process.

Mirror neurons and autism

Recently there has been a lot of popular attention to the role of the Mirror Neuron System (MNS) and its possible role in the explanation of autistic spectrum disorder. The MNS was discovered by co-incidence by Rizolatti et al (1996) as a part of the inferior frontal and temporal zone. The mirror neurons fire not only when someone is doing a particular action but also when that person is watching somebody doing the same action. The MNS has to do, not directly with imitation but with the understanding of actions, as a kind of automatic re-enactment, and with the interpretation of the intention of other people. It has been hypothesized - documented by fMRI and other

neuroimaging studies - that the MNS is involved in social cognition, learning through imitation, mind reading and empathy, which are all hampered in individuals with autistic spectrum disorder (Hadjikhani, 2007). However, the hypothesis is still controversial; some authors have found no impediment of action understanding in individuals with ASD and claim that multiple brain systems are involved in ASD (de Hamilton e.a., 2007). There is a wide-spread tendency of reductionist thinking in neurosciences, i.e. to reduce the complex functioning of a human being to its neurobiological functioning, and reversely, to think in simple causal interactions, i.e. to infer that a perceived neurobiological phenomenon is the cause of an associated function. There is yet little research about the plasticity of the MNS in relation to ASD. If the brain neurocircuitry is plastic as a result of ecological influences and experience, there is no reason to discard the idea that experience (positive or negative) may not influence the networking connections of the MNS. Autism is a multifactorial condition and may have multiple causes. There is preliminary evidence that intervention oriented at the mediation of understanding empathy, understanding emotions and the regulation of executive functions, when done in an ecological way has a positive effect on the modifiability of children with ASD (Kozulin e.a., 2010).

A central hypothesis: modifiability, plasticity and ecology

In conclusion, neurosciences offer ample evidence for Feuerstein's MLE and SCM theory. Although direct neuroimaging evidence on the specific neurobiological correlate of Mediated Learning Experience is lacking up till now, there is some indirect evidence: brain plasticity allows children to substantially become modified and adapt, to develop their cognitive, socio-emotional, motor, language and academic competences, despite genetic, brain or autistic conditions. Neuronal plasticity is ecological and experience-dependent. Development is the result of a complex puzzle of "ecological" influences. In those ecological influences, "outer" as well as "inner" factors are of fundamental importance. The outer factors are those that are readily visible: they are formed by a combination of interventions, environments, constituted by what people actually do; the intensity of learning, the opportunities for learning, practice time to learn some activities, etc. The inner factors

are more intangible, in the sense of attitudes, the "energy" between people, what people actually experience inside, what really drives them, the "spark" of how they mediate. The concept of MLE is sufficiently broad to encompass all these aspects.

However, some caution has to be expressed. First of all, plasticity may have adverse outcomes. Stimulation leading to synaptic connection expansion does not necessarily lead to positive functional outcomes. Second, mediated learning experience may seem a simple theory, but the complexity and unpredictability of a child's ecology make it difficult to reproduce. On the one hand unpredictability – as an inherent property of complex systems – gives sufficient theoretical grounding to Feuerstein's idea that development cannot be predicted on the basis of static tests (IQ tests, developmental tests, learning tests, brain examinations or other) and it justifies his vehement criticism of contemporary test practice. On the other hand, it makes intervention outcomes also unpredictable. This is the reason why comparative effect studies are bound to remain controversial. Almost any activation method, whether it is a specific cognitive activation programme like FIE, or another one, when it is done with mediation, might have a positive effect. Nevertheless current neuroscientific evidence has proven that Feuerstein with his bold hypothesis of modifiability and mediated learning was 50 years ahead of his time.

Acknowledgements

This article has been written as part of the ENABLIN+ project. This project has been funded with support from the European Commission, Life Long Learning Programme. This document reflects the views of the authors only, and the Commission cannot be held responsible for any use which may be made of the information contained therein. The author wishes to thank Eva Ohnesorge feedback on the case studies.

References

Alder, J., Thakker-Varia, S., Black, I.B. (2002), Transcriptional analysis in the brain: trophin induced hippocampal synaptic plasticity, *Neurochemical Research,* 27(10), 1079 92

Aoki, C., & Siekevitz, P. (1988). Plasticity in brain development. S*cientific American* 259, 56-64

Arnott, G., Guieu, J. D., Blond, S., Charlier, J., Vandeloo, F. M., Lejeune, E., Clarisse, J., De, Landsheer E., & Laine, E. (1982). Hémispherectomie droite totale. Etude neurophysiologique après vingt ans. *Revue Neurologique* 138, 305-316

Austin, G. M., & Grant, F. C. (1955). Physiologic observations following total hemispherectomy in man. *Surgery* 38, 239-257

Bangert, M. & Altenmüller E.O.(2003), Mapping perception to action in piano practice, *BMC Neurosciences*. 2003; 4**: 26**

Behen, M., Juhász, C., Wolfe-Christensen, C., Guy,W., Halverson, S., Rothermel,R., Janisse, J., Chugani, H.T., (2011), Brain damage and IQ in unilateral Sturge–Weber syndrome: Support for a "fresh start" hypothesis, *Epilepsy & Behavior*, 22 (2): 352–357

Bigler, E.D. (1995) Brain morphology and intelligence. *Developmental Neuropsychology,* 11 (4), 377-403

Black, I. (1999), Trophic regulation of synaptic plasticity, *Journal of Neurobiology*, 41 (11), 108-118

Blackman, J. A., McGuinness, G. A., Bale, J. F., & Smith, W. L. (1991). Large postnatally acquired porencephalic cysts: unexpected developmental outcomes. *Journal of Child Neurology* 6, 58-64.

Buckley, S. (2000), *Speech and language development of children with Down Syndrome – an overview*. Southsea (Hamps. UK): Down Syndrome Educational Trust

Carr, L.J.(1996), Development and reorganisation of descending motor pathways in children with hemiplegic cerebral palsy, *Acta Paediatrica Supplement,* 416, 53-57

Ceci, S. J., & Liker, J. K. (1986). A Day at the Races: A study of IQ, Expertise, and Cognitive Complexity. *Journal of Experimental Psychology*: General 115, 255-266

Chen, R., Cohen, L.G., Hallett, M. (2002), Nervous system reorganization following injury, *Neuroscience,* 111(4):761-73

Clark, A. & Chalmers, D. (2010), The Extended Mind, in: Menary, R., *The Extended Mind*, Cambridge (Mass.): MIT

Cromwell, H.C., Panksepp,J. (2010) Rethinking the cognitive revolution from a neural perspective: How overuse/misuse of the term 'cognition' and the neglect of affective controls in behavioral neuroscience could be delaying progress in understanding the BrainMind, *Neuroscience & Biobehavioral Reviews,* 35 (9): 2026-2035

Damasio, A.R., Lima, A., Damasio H. (1975), Nervous function after right hemispherectomy, *Neurology,* 25: 89-93.

de C. Hamilton, A., Brindley, R.M., Frith, U. (2007)Imitation and action understanding in autistic spectrum disorders: How valid is the hypothesis of a deficit in the mirror neuron system? *Neuropsychologia,* 45 (8):1859-1868

de Graaf-Peters, V., Hadders-Algra, M. (2006), Ontogeny of the human central nervous system: what is happening when? *Early Human Development*, 82(4):257-66

Devlin, A.M, Cross, J.H. Harkness, W., Chong, W.K., Harding, B., Vargha-Khadem, F., Neville, B.G. (2003), Clinical outcomes of hemispherectomy for epilepsy in childhood and adolescence, *Brain,* 126, Pt 3, 556-66.

Eccles, J. C., & Robinson, D. (1985). *The wonder of being human.* Boston/London: Shambhala.

Edelman, G.M. *(*1989*) Neural Darwinism. The Theory of Neuronal Group Selection.* Oxford: Oxford University Press.

Engels, P. (2006), "It's a nice life." My Experiences with Inclusive Education, *Transsylvanian Journal of Psychology - Erdély Pszichológiai Szemle*, Special issue Vol. Supplement 2006, part 1, pp.25-30

Farmer, S. F., Harrison, L. M., Ingram, D. A., & Stephens, J. A. (1991). Plasticity of Central Motor Pathways in children with hemiplegic Cerebral Palsy. *Neurology* 41, 1505-1510

Feuerstein, R. (1979). Ontogeny of learning in man. In Brazier, M. A. B. (Ed.), *Brain Mechanisms in Memory and Learning: From the Single Neuron to Man* (pp. 361-372). New York: Raven Press.

Feuerstein, R., Feuerstein, R.S., Falik, L.H. and Rand, Y. (2006). *Creating and Enhancing Cognitive Modifiability: The Feuerstein Instrumental Enrichment Program.* Jerusalem: International Centre for the Enhancement of Learning Potential

Feuerstein, R., Klein, P.S. & Tannenbaum, A. (1991), *Mediated Learning Experience. Theoretical, Psychological and Learning Implications*, London: Freund Publishing House

Feuerstein, R., Rand Y., & Rynders JE. (1988). *Don't accept me as I am: helping "retarded" people to excel.* New York: Plenum

Garbo, R. (2009), *Prospettiva inclusive e percorsi di vita*, Milano: Edizioni Junior

Geersa, A.E.., Nicholas, J.G., Oetting, J., Redmond, S. (2013), Advantages of Early Cochlear Implantation for Spoken Language Development. Door:, *Journal of Speech, Language & Hearing Research*, 56, 643-653

Goodman, R. A., & Whitaker, H. A. (1985). Hemispherectomy: A Review (1928-1981) with Special Reference to the Linguistic Abilities and Disabilities of the Residual Right Hemisphere. In Best, C. T. (Ed.), *Hemispheric function and collaboration in the child* (pp. 121-155). Orlando & New York: Academic Press

Grandin T and Scariano MM (1996), *Emergence, labelled autistic*, New York: Warner Books

Gunnar, M. (2001), Effects of early deprivation: Findings from orphanage-reared infants and children, in Nelson, C. & Luciana, M., *Handbook of Developmental Neuroscience*, Cambridge (MA): MIT Press

Hadders-Algra, M. (2000), The Neuronal Group Selection Theory: a framework to explain variation in normal motor development, *Developmental Medicine & Child Neurology*, 42: 566–572. doi: 10.1111/j.1469-8749.2000.tb00714.x

Hadjikhani, N. (2006), Mirror neuron system and autism, in Carlisle, P. (Ed.), *Progress in Autism Research*, 151-166

Hannan, A.J. (2014), Review: Environmental enrichment and brain repair: harnessing the therapeutic effects of cognitive stimulation and physical activity to enhance experience-dependent plasticity, *Neuropathology and Applied Neurobiology*, 40: 13–25

Hebb, D. O. (1949). *The Organization of Behavior: A Neuropsychological Theory*. New York: Wiley and Sons.

Hécaen, H., Perenin, M. T., & Jeannerod, M. (1984). The effects of cortical lesions in children: language and visual functions. In Almli, C. R., & Finger, S. (Eds.), *Early Brain Damage, Volume 1, Research Orientations and Clinical Observations* (pp. 277-298). Orlando New York: Academic Press

Hubel, D. H., & Wiesel, T. N. (1963). Receptive fields of cells in striate cortex of very young, visually inexperienced kittens. *Journal of Neurophysiology* 26, 994-1002

Johnston, M.V. (2009), Plasticity in the developing brain: implications for rehabilitation, *Research in Developmental Disabilities*, 15: 94 – 101

Kaplan, M. S. (1988). Plasticity after brain lesions: contemporary concepts. *Archives of Physical Medicine and Rehabilitation* 69, 984-991

Keller, H. (1903). *The story of my life*. London: Hodder & Stoughton.

Kleim, J.A. & Jones, T. (2008) Principles of Experience-Dependent Neural Plasticity: Implications for Rehabilitation After Brain Damage*, Journal of Speech, Language, and Hearing Research,* 51: 225–239

Klintsova, A. & W.T. Greenough (1999), Synaptic plasticity in cortical systems, *Current Opinions in Neurobiology*, 9 (2), 203-208

Kozulin, A., Lebeer, J. , Madella-Noja, A. , Gonzalez, F. , Jeffrey, I. , Rosenthal, N., Koslowsky, M, (2010) Cognitive modifiability of children with developmental disabilities: a multicentre study using Feuerstein's Instrumental Enrichment – Basic program, *Research in Developmental Disabilities*, 31, 551–559

Lebeer, J. (1998) How much brain does a mind need? Scientific, Clinical and Educational Implications of ecological Plasticity *Developmental Medicine and Child Neurology* **40***: 352-357*

Lebeer J & Rijke RPC (2003), Ecology of development in children with brain impairment, *Child: Care, Health & Development*,29 , 2, 131-140

Lebeer, J. (2005), Shifting perspective: dynamic assessment of learning processes in children with developmental disabilities, *Erdélyi Pszichológiai Szemle (Transsylvanian Journal of Psychology), Special Issue on Dynamic Assessment*, 1, 55-85

Lebeer, J. (2006), Clues to inclusive and cognitive education: reconciling needs to integrate and to activate learning processes, in *Erdélyi Pszichológiai Szemle (Transsylvanian Journal of Psychology),* special issue on inclusive and cognitive education, 2006 Supplement, pp.31-66

Leel-Ossy L., Szücs, I., Almási, K. (2006), A case of Schizencephaly with polymicrogyria, *Clinical Neuroscience [Ideggyógyászati Szemle],* 60 (1): 56-59

Lewin R. (1980) Is your brain really necessary Science 210: 1232-1234

Maguire, E. e.a. (2000), Navigation-related structural change in the hippocampi of taxi drivers, *Proceedings of the National Academy of Sciences*, vol. 97, 4398-4403

Malson, L. & J. Itard (1972), *Wolf children, The Wild boy of Aveyron*, London: New Left Books

Maria, B. L., Zinreich, S. J., Carson, B. C., Rosenbaum, A. E., & Freeman, J. M. (1987). Dandy-Walker Syndrome Revisited. *Pediatric Neuroscience* 13, 45-51.

Marshall, J. F. (1985). Neural plasticity and recovery of function after brain injury. *International Review of Neurobiology* 26, 201-247

McVicker-Hunt, J. (1986), The effect of variations in quality and type of early child care on development, *New Directions for Child Development*, 32: 31-48

Merzenich, M. (2000), Seeing in the sound zone, *Nature,* 404, 820-821

Mintzker, Y. (1991), When the baby does not smile back. Obstacles to successful mediated learning experience, in: Feuerstein, R., Klein, P.S. & Tannenbaum, A., *Mediated Learning Experience. Theoretical, Psychological and Learning Implications*, London: Freund Publishing House

Morgan, C., Novak, I. & Badawi, N. (2014), Enriched Environments and Motor Outcomes in Cerebral Palsy: Systematic Review and Meta-analysis, *Pediatrics,* 132:e735–e746

Morris, R. G., Kandel, E. R., & Squire, L. R. (1988). The neuroscience of learning and memory: cells, neural circuits and behavior. *Trends in Neurosciences* 11, 125-127

Musso, M.C., Weiller, C., Kiebel, S., Müller S.P., Bülau, P., Rijntjes, M.(1999), Training-induced brain plasticity in aphasia, *Brain*, 122, 1781-1790

Nithianantharajah, J., Barkus, C., Murphy, M., Hannan, A.J., Gene–environment interactions modulating cognitive function and molecular correlates of synaptic plasticity in Huntington's disease transgenic mice, *Neurobiology of disease,* 29 (3): 490–504)

Noë, A. (2009), *Out of our heads. Why you are not your brain and other lessons from the biology of consciousness,* New York: Hill & Wang

Pribram, K. H. (1971). *Languages of the brain.* Englewood Cliffs- N.J.: Prentice Hall.

Prigogine, I., & Stengers, I. (1984). *Order out of chaos.* London: William Heinemann.

Rakic, P. (2002), Neurogenesis in adult primates, *Progress in brain research*, 138, 3-14

Ramakers, G.J. (2002), Rho proteins, mental retardation and the cellular basis of cognition, *Trends in Neurosciences*, 25 (4), 191-199

Rijke RPC (1993) Health in medical science. From determinism towards autonomy. In: Lafaille R & Fulder S (Eds). *Towards a new science of health*. London: Routledge, 74-83

Roe, A., Pallas, S., Kwon, Y., Sur, M. (1991), Visual projections routed to the auditory pathway in Ferrets: receptive fields of visual neurons in primary auditory cortex, *Journal of Neurosciences*, 12, 3651-3664

Rosenzweig, M.R., Bennet E.L. (1996) Psychobiology of plasticity: effects of training and experience on brain and behavior. *Behavioural Brain Research* 78: 57-65

Shahbazian, M.D. & Zoghbi, H. (2002). Rett Syndrome and MeCP2: Linking Epigenetics and Neuronal Function, *American Journal of Human Genetics*. 71(6): 1259–1272

Sharma, R. (2002), *My two years in the life of Alex: Mediated Learning Experience with a boy who had undergone a left hemispherectomy*, Exeter (UK): University of Exeter, doctoral dissertation

Skuse, D. (1984), *Genie: a psychological study of a modern day "wild child"*, New York: Academic Press

Smith, A., Sugar, O. (1975). Development of above normal language and intelligence 21 years after left hemispherectomy. *Neurology* 25: 813-818

Smith, A. (1984). Early and long-term recovery from brain damage in children and adults: evolution of concepts of localization, plasticity, and recovery. In Almli, C. R., & Finger, S. (Eds.), *Early Brain Damage, Volume 1, Research Orientations and Clinical Observations* (pp. 299-324). Orlando New York: Academic Press

Speed, A., Verzi, S.J., Wagner, J.S., Warrender, C. (2010), Optical holography as an analogue for a neural reuse mechanism, *Behavioral and Brain Sciences,* 33: 245–313

Squire,L (2004)Memory systems of the brain: a brief history and current perspective, *Neurobiololy of Learning and Memory,* 82(3), 171-7

Teyler, T. J., & Fountain, S. B. (1987). Neuronal plasticity in the mammalian brain: relevance to behavioral learning and memory. *Child Development* 58, 698-712

Trevarthen C. (1990) Growth and education of the hemispheres. In C. Trevarthen (Ed), *Brain cricuits and functions of the mind: Essays in honour of Roger W. Sperry.* New York: Cambridge University Press.

Van Praag, H., Kempermann, G., Gage, F. (2000), Neural consequences of environmental enrichment, *Nature Review of Neurosciences,* 1(3):191-8

Varela, F., Thompson, E. & Rosch, E. (2000), *The Embodied Mind. Cognitive Science and Human Experience*. Cambridge (Mss.): MIT Press

Vargha-Khadem, F. Carr, L.J., Isaacs, E., Brett, E., Adams, C., Mishkin, M. (1997), Onset of speech after left hemispherectomy in a nine-year-old boy, *Brain*, 120 (Pt 1), 159-82

Zhang X., Sheng-yuY. (1984) Report of ten cases of porencephaly. *Chinese Medical Journal* 97: 786-788

From Dynamic Assessment to Intervention: Can we get there from here?

CAROL S. LIDZ [1]
H. CARL HAYWOOD [2]

Abstract

The dynamic model of assessment is one of Reuven Feuerstein's most important and influential contributions to both theory and practice, one that crosses boundaries of content domain, age, gender and ethnicity, venue, and purpose. Feuerstein not only reinforced the desirability of including intervention within the assessment process itself as a way of increasing the validity, fairness, and relevance of assessments, but he designed and developed one of the most important, and certainly the most influential, of actual procedures. No longer in its infancy, there are now substantial data to support the validity of specific dynamic procedures of a great variety and application. While not assuming that this challenge has been sufficiently met, the greater challenge of determining validity through the ultimate criterion of improvement of student learning in response to implementation of dynamic assessment has yet to be addressed adequately. This is the holy grail of any assessment designed for application in a clinical or educational setting. The authors discuss the intermediate path on this road from assessment to implementation of the resulting recommendations, to response to intervention.

Keywords

dynamic assessment, response-to-intervention, cognitive assessment, mediated learning experience

Introduction

The dynamic model of assessment is one of Reuven Feuerstein's most important and influential contributions to both theory and practice, one that crosses boundaries of content domain, age, gender and ethnicity, venue, and purpose. Feuerstein not only reinforced the desirability of including inter-

1. Philadelphia, Pennsylvania (USA) Address of correspondence: zdilsc@aol.com;
2. Professor of Psychology, *emeritus*, Vanderbilt University, Nashville, Tennessee (USA)

vention within the assessment process itself as a way of increasing the validity, fairness, and relevance of assessments, but he designed and developed one of the most important, and certainly the most influential, of actual procedures (Feuerstein, Rand, & Hoffman, 1979; Feuerstein, Feuerstein, Falik, & Rand, 2002).

Dynamic assessment (DA) describes procedures that include interaction during the course of the assessment, address learning processes related to a wide variety of domains, and focus on responsiveness of the learner to the interactions. The focus is on attempts to move the learner to a higher level of mental functioning through creation of zones of proximal development (Haywood & Lidz, 2007).

No longer in its infancy, there are now substantial data to support the validity of specific dynamic procedures of a great variety and application (see dynamic assessment bibliography at Vanderbilt University, Peabody Library website). While not assuming that this challenge has been sufficiently met, the greater challenge of determining validity through the ultimate criterion of improvement of student learning in response to implementation of dynamic assessment, has yet to be addressed adequately. This is the holy grail of any assessment designed for application in a clinical or educational setting.

In this article we discuss the intermediate path on this road from assessment to implementation of recommendations, to response to intervention. Without implementation of a plan that directly reflects the results of the assessment, there is no truly adequate test of its treatment validity.

Despite high hopes of closing (at least narrowing) the gap between assessment and intervention, there remains an unfortunate disconnect between most of the assessment procedures developed and the need for them to generate information that informs intervention. Most of the DA research addresses issues of predictive validity, and within that, the ability to discriminate between groups. The focus of most research concerned with school achievement (usually reading and math) documents positive relationships between response to the intervention embedded within a variety of dynamic assessment procedures (e.g., Lidz & Greenberg; 1997; Lidz, Jepsen, & Miller, 1997; Petersen, Allen, & Spencer, 2014; Stevenson, Hichendorff, Resing, Heiser, & de Boeck, 2013; Stevenson, Bergwerff, Heiser, & Resing, 2014). Another approach has been to investigate the underlying neuropsychological processes associated with learning during the course of the dynamic assess-

ment to enable inferences to be made about the processes that may possibly be targeted by subsequent interventions that relate to the ability to transfer learning from the assessment to the subsequent intervention (Stevenson, Heiser & Resing, 2013). The closest most of these studies get to documenting prescriptive information generated by the procedures is their contribution to group treatment assignment. There is also a significant literature to document that teachers value the results from dynamic assessments, which they claim have positively influenced their practices and perceptions of their students (Bosma, 1972; Delclos, Burns, & Kulewicz, 1987; Delcos, Burns, & Vye, 1993; Hulbert, 1995). This is not to dismiss the value of the currently available research results they do document, as such information is surely relevant and important, but if one of the unique contributions of the DA model is to refine the prescriptive contributions of diagnostic assessment, then there remains a rather wide gap.

Closing the gap between dynamic assessment and intervention

The first step on the road to closing the gap between dynamic assessment and intervention necessitates a close match between the two venues, that is, between the content of the assessment and the ultimate domain to which the information is to generalize. This is the basis of transfer. Assessment (if it involves learning) is in essence an issue of transfer. It is a sample of the situation to which the information derived is to ultimately apply. Therefore, if the assessment is to inform clinical practice intervention, then the assessment should logically include content that represents this ultimate target. In the case of education settings this argues of course for a curriculum-based approach to assessment. This does not, however, require avoidance or omission of assessment of basic processes that underlie the learning involved in either setting. Intervention that targets reading should of course involve assessment of tasks that involve reading, but should as well include processes (such as attention, self-regulation, visual/auditory perception) that relate to the ability to master reading. Similarly, assessment that addresses clinical issues may well include cognitive and social/affective processes and assumptions that underlie explicit behaviors and thoughts.

The second point is that there needs to be a focus on what can be done to address the issues that generated the assessment. It is not sufficient to de-

scribe what is wrong, nor is it relevant nor sufficient to focus on determination of a label or category of classification unless, of course, this has direct implications for intervention (rarely the case).

The third point is that inclusion of interventions in the assessment should represent those that are meaningful, preferably evidence-based, and at least experience-based for the setting to which they are to generalize.

This requires a knowledge and experience base for the assessor, who functions in a hypothesis-driven manner in carrying out the assessment.

Interventions are not mere trial and error (though if serendipity works, keep it!). Interventions should make sense and be do-able by the professionals who are to carry them out following the assessment. If not easily implementable, then the appropriate consultation and training needs to be provided. The assessment is the opportunity to provide the evidence suggested in an evidence-based approach. Evidence is not evidence until it is shown to be effective for the individual to whom it is to apply. Evidence from research on large groups is merely suggestive of what might work for the individual. It has little to offer the individual being assessed without demonstration of its effects on this individual.

Use of the DA model supports the use of a formative approach to assessment, one that results in ongoing monitoring and re-assessment. DA can be conceived of as creation of zones of proximal development, zones that continually change as the learner moves to the next levels. However, in our model (Haywood & Lidz, 2007), DA is not mere trial teaching. Our approach to DA involves teaching to the cognitive processes that underlie the target content. The curriculum-based approach to DA connects these processes to academic achievement, and the clinically-based approach makes the connection to processes underlying functional and dysfunctional behavior.

Areas of active research that attempt to move us along on the journey

It is encouraging that there is a considerable amount of research and development in the area of dynamic assessment (see Peabody Library at Vanderbilt University's Dynamic Assessment website). Much of this involves creation of new procedures; some discuss general issues, and others provide validity data for existing applications. In this article we select a sample of stud-

ies and discussions from the most active domains that specifically address issues involved in moving forward on the journey from assessment to intervention. This is not intended to be comprehensive but merely touches the bases of work that is available.

Guided Prompt Model

Campione and Brown (1987) were among early researchers who focused not only on assessment as a vehicle of identification of students with special needs, but engaged in steps of task analysis of academic domains to help determine the match between skills and knowledge needed for their mastery and development of competence. Their research suggested the lack of success of traditional assessment approaches, even those that generated profiles of strengths and weaknesses, to promote academic competence in low functioning students. They advocated for the need to "evaluate as directly as possible the particular processes underlying successful performance …(and suggested that)….the assessment should ideally be situated within a specific domain" (p. 88). Unfortunately, these researchers devised a metric that focused quantitatively on the amount of aid needed to develop mastery, which has the inevitable consequence of generating classification information that is limited in its implications for intervention and instruction. That is, they analyzed the task, not the learner, other than the learner's intensity of need for help. Nevertheless, this approach has the advantage of improving the basis for classification when this is the chosen goal of the assessment (e.g., Lidz & Macrine, 2001). This choice of approach limits the attempt to close the assessment-intervention gap, though has been quite successful in generating useful and researchable data. However, it could also be argued that the "reciprocal teaching" approach developed under these authors' auspices offers one model of closing the gap, since there is virtually no separation between assessment and intervention. The teacher is the mediator who engages the students in a complex intervention that involves specific target skills within the domain of reading comprehension (stop and summarize, formulate questions, clarify inconsistencies, predict what comes next). The teacher observes and provides ongoing intervention (primarily modeling and feedback) during the course of provision of the intervention (the same intervention to all). In this particular model, it is not entirely clear whether this is indeed an

example of dynamic assessment (Karpov, 2008). It is certainly a model of good teaching practice, as well as perhaps an example of formative assessment. It could perhaps move closer to DA if the issues of struggling students were addressed in terms of the inferred obstructions to their development of competence, followed by interventions that specifically addressed these needs.

Curriculum-based Assessment

The Lidz & Jepsen Application of Cognitive Functions Scale (ACFS; in Haywood & Lidz, 2007) is an example of a curriculum-based procedure that explicitly attempts to close the gap between assessment and intervention. Not only does it include content and interventions that relate directly to curriculum and teaching practices typical of well designed early childhood settings, but the interpretive information accompanying the procedure includes educational objectives, interventions, and formats that lead to development of Individual Educational Programs and follow-up/tracking for the objectives derived. The ACFS subscales represent basic cognitive processes that underlie successful mastery of academic achievement domains. These include visual and auditory memory, classification, sequencing, planning, and perspective-taking. The Behavior Observation Rating Scale rates the behavior of children that also relates directly to their ability to succeed in an academic environment, such as self-regulation, flexible thinking, persistence, social interaction and interactive communication. The pretest-intervene-posttest format not only records the responsiveness of the learner during the course of the assessment, but provides a detachable posttest that can be used by teachers or educational assessors to track the students' progress in response to implementation of the recommendations for intervention deriving from the assessment.

An example of the route from assessment to classroom intervention derived from the ACFS is the subscale of Classification. This task requires the child to sort blocks into categories based on color, shape, and size. The intervention embedded within the assessment teaches the child how to do this, using attribute blocks. If it is determined that this is an area that requires attention and further development, the following objectives become part of the child's Individualized Educational Program:

Classification:

a) Child will group objects on the basis of abstracted features of color, size function, shape.
b) Child will change the basis of grouping objects when asked to "do it another way."

Subskills:

- ability to detect distinctive features
- ability to respond to directions
- ability to make groups based on abstracted distinctive features
- application of grouping concepts across variety of materials, such as toys, clothes, foods (real simulations, as well as pictures).

Suggested classroom interventions for these objectives are derived directly from the assessment:

- Work on visual matching to a model object by attribute,
- Place objects with the same color in the designated box.
- Teach child to sort by at least two attributes; then ask child just to "sort."
- Once sorted, ask the child to do it another way.

To assess the child's progress with these objectives, the teacher (or another assessor) can then re-administer the post-test of the Classification subscale.

In the case of the behavior recorded on the Observation form, there are no standardized interventions embedded within the procedure. Nevertheless, suggested interventions for each behavior are offered in the test manual, and the assessor is free to intervene as needed during the course of the assessment.

For example, the following interventions, derived from research and teaching best practices, are offered to address concerns about the child's difficulty with self-regulation:

- Model and encourage task-related self talk.
- Provide opportunities for role playing teacher or parent.
- Change use of time out from use for punishment into use as a self-selected tool for self-control, that is, from time out to time to "cool out."
- Use self-calming routines such as hands in lap, zipper lip, get eye contact with teacher/parent, breathing, count to ten.

The ACFS is now available in translation and adaptation in Spanish (Calero et al., 2013), Norwegian (www.pedverket.no) and Czech (Lenka.Krejcova@ff.cuni.cz). Translations (without accompanying packaging) are also available in Dutch (Van der Aalsvoort & Lidz, 2007) and German (Schevel, 2008; Wiedl, Mata, Waldorf & Calero, 2014), and data related to its use in Australia and England are also available.

An even more direct attempt to close the assessment-intervention gap is the Curriculum-based Dynamic Assessment (CBDA) model proposed by Lidz (in Haywood & Lidz, 2007). In this approach, the assessor selects a target task from the learner's actual school curriculum. This task should reflect a specific area of concern from the referral, and can be a homework assignment or a classroom lesson. The assessor then engages in a process- analysis of that task to determine the neuropsychological processes related to development of competence in that domain. The choices of processes reflect those that relate to successful school achievement, such as sensory intactness, attention, perception, memory, language, reasoning, and metacognition; the assessor also needs to specify the basic knowledge and skill base necessary to mastery. Based on the various sources of information available to the assessor at the time (interview, observation, other assessments), the assessor then makes a judgment about the intactness of the learner's processes in relation to those demanded by the task. The issue is the match (or lack) between what the task requires for mastery and the intactness of those processes within the learner's repertory. The assessor then addresses the gaps with interventions that are available either within the literature, the classroom, or the assessor's experience to explore the learner's response to interventions provided within the assessment. The intervention targets the processes related to develop-

ment of competence in the content domain. For example, a student is referred for difficulty with spelling. The ability to spell has a high loading on visual and auditory memory; there are also issues of visual and auditory perception, as well as the language knowledge base issue of having the words to be spelled within the student's vocabulary repertory. Through error analysis and other assessment sources, the assessor determines that the student lacks strategies for placing information into memory storage. With knowledge of viable memory strategies, the assessor tries out a variety of strategies, such as visualization, to determine their degree of success in improving the student's ability to spell.

Despite the fact that this is a highly qualitative approach, it is possible to devise scoring rubrics that are specific to the domain, and the entire procedure can be administered within the pretest-intervene-posttest format.

In the current example, a teacher-made spelling test can be used, and items selected from this test pulled out for alternative pre/post tests. Once the pretest is administered, those items can be used for the intervention, since the posttest would use the alternative set. The student is given the posttest words to learn to spell, and then tested on the set. Alternatively, the original pretest words can be used, which would still provide useful information about the student's success with learning that set. This approach obviously places a great deal of work and thought on the assessor, but, in actuality, it is possible to do a meaningful (and very informative) CBDA within as brief a time as 20-30 minutes if the assessor is very careful to select a domain and task that directly represents referral concerns. The obvious advantage is that it is not possible to get closer to the instructional setting than to use the actual material content of that setting.

Speech-language pathology:

Dynamic assessment has been of particularly strong interest to researchers and practitioners in the domain of speech/language pathology.

Peña and Gillam (2000) offer a significant contribution to this domain in their development of three procedures that target the content areas of vocabulary development, narrative, and explanatory discourse. In these procedures there is a direct relationship between the semi-scripted mediations incorporated into their pretest-mediate/intervene-posttest design and the re-

sulting recommendations to the teachers and clinicians who will be working with the referred children. Their interventions follow a framework suggested by Lidz's (1991) modification of Feuerstein's Mediated Learning Experience outline, and deliver a content-related array of mediation of intent, meaning, transcendence, competence, along with profiling the learner's responsiveness to the interventions in terms of processes involved with initiation/maintenance of attention, task-related ability to discriminate/compare and comment, self-regulation, persistence and planning. In all three procedures, the assessor helps the learner understand the reason for learning the content and tries to develop a need to develop competence. The strategies relevant to the tasks are reviewed, with multiple opportunities offered for in-context practice. The assessor also completes a 'modifiability scale' to provide qualitative description of the responsiveness of the learner to the interventions. The information available to the clinician from this assessment includes the degree and nature of effectiveness of the interventions, and profile descriptions of the learning processes and degree of modifiability of the learner.

Second language learning

Researchers in the domain of second language learning tend to pay especially close attention to the details of the interaction portion of the assessment. However, they also tend to gravitate toward the graduated prompt model, which then leads almost naturally to computerization of their assessments (e.g., Teo, 2012). With the use of computers in this domain, as in that of mathematics, there is often an adaptive component, with the input from the computer able to adjust to the responses of the learner. One of the interesting findings is that this approach has resulted not only in teaching of domain content, but seems to promote metacognitive functions in the learner, for example, improved self-regulation, monitoring, and evaluation (Teo, 2012).

However, quite in contrast to a computerized, guided prompt approach is the Lantolf and Poehner study (2010) that offers an example of ultimate blending of DA and intervention in their description of an elementary school teacher of Spanish to English dominant children (although these authors also use a guided prompting approach in their second language assessments).

The teacher in this project was self-motivated to find a way to move the principles and practices of DA developed for second language learners, as described in the Lantolf and Poehner Teacher's Guide (2006), into her own practices as an itinerant Spanish language teacher. These authors then intended to incorporate the information learned from this project into their guide to enhance its relevance for DA-guided teaching practices. Having a teacher blend DA with her own teaching practices of course represents the ultimate closing of the assessment-intervention gap. The ability to do this, ideally in relation to the DA-based information offered by diagnostic specialists, represents an optimal outcome for the larger assessment process. Both teachers and parents as ultimate implementers can move from passive receivers of information to active users and ongoing developers of further information.

A central aspect of such a model of implementation is the mediational component of feedback. Lantolf and Poehner (2010 cite research findings that suggest the superiority of explicit metalinguistic feedback for mastery of specific content products, but argue for the importance of both implicit and explicit mediation for effective internalization and self-regulation of learning-as-process (see Lidz, 1991, for a model of mediation that promotes self-regulation in the Mediated Learning Experience Rating Scale).

The teacher in this case study was essentially trying to enhance her mediation-based instruction. She focused each of her lessons on a continuum of choices of mediations (aka graduated prompts) that offered a total possibility of six to eight moves by the mediator as follows:

1. pause
2. repeat phrase as a question
3. repeat the part of the phrase that contains the error
4. point out to the student that there is an error and ask student to identify it
5. point out the error for the student
6. ask an either/or question
7. offer the correct response
8. provide explanation of why

The degree to which this is 'mediation' can be argued (especially from a Feuersteinian point of view), but it is clear that such an approach could enhance teachers' ability to track and record the students' responsiveness and the de-

gree of success of their instruction. Provision of the results of the application of this approach may itself provide meaningful feedback to the students, and, in the case of effect upon the teacher, the model may provide regulation and enhancement of her attention to the progress and needs of the students en-route to improved competence.

Poehner & Compernolle (2011) described the intertwined nature of their mediation-as-assessment and intervention for second language learners of French.

Also focusing on the mediational interactions between assessor and learner, Alavi, Kaivanpanah, and Shabani (2012) developed an inventory of strategies used during the course of group dynamic assessment of their English as a Second Language learners in Iran. Such a list is useful in providing a repertory to assessors to guide their interactions, which would then provide an outline for development of recommendations directly from the assessment. From their study emerged a list of eight strategies:

- confirmation or rejection of the response
- reply of either the entire segment or portion of the content
- putting words together
- repetition of the error as a question
- offering contextual reminders
- offering metalinguistic reminders
- use of a dictionary
- provision of the correct response with an explanation

Reading/literacy

Carney and Cioffi (1990; 1992), in their case example, point to a long history among researchers of reading in the generation of interventions based on an interactive approach to assessment. Within the reading domain they explore the effects of a DA approach in relation to word recognition and text comprehension, and describe a graduated prompting approach that includes a series of instructional episodes designed to determine the degree of effectiveness of a variety of instructional alternatives. The type of instruction provided is individualized to the nature of the errors and perceived needs of the student. The information derived from this approach includes effectiveness of instruction for the student on speed, accuracy, use of prior knowledge, and

integration of concepts (in the case of comprehension). Considerable judgment and knowledge on the part of the assessor in the domain of reading would be necessary. The primary issue for these researchers is that the instruction is embedded within their assessment and directly applicable to subsequent remediation efforts.

Guterman (2010) offers another example within the reading domain of the effectiveness of incorporating mediation of metacognitive processes within the instruction and assessment of this content. Her research generated helpful questionnaires targeting metacognitive processes that could easily move information about the learner from the assessment situation into the classroom.

Mathematics

Mathematics is a domain particularly amenable to computerized presentation, and this option has been applied to dynamic assessment procedures by researchers such as Gerber (2000). The DA model, in his case called Dynomath, focuses on multidigit multiplication for secondary level students diagnosed with learning disabilities. Gerber designed the program to reflect the basic processes (specifically Working Memory), procedures, and knowledge base involved in mastery of this content with the goal of determining the possible relevant individualized interventions to enable the successful progress of the students. The program provides error-based prompts, and tracks the student's error history and responses to strategy-based prompts. Information regarding the student's speed and accuracy is available as well. The information available to teachers from this procedure includes the next instructional step, details about the student's zone of proximal development such as the speed and nature of responsiveness to the direct and strategic instruction.

Jeltova and her colleagues (2011) offer an example of group administered DA in the mathematics domain. This is part of their larger program of 'dynamic instruction' that incorporates Vygotsky-based dynamic principles of interaction into both the curriculum and the curriculum-related dynamic assessment. In this model the assessment-instruction relationship is assured.

Tzuriel and Trabelsi (2014) described their approach that sets a clear path between assessment and intervention. This approach connects the Seria-

Think Instrument, a DA assessment procedure (Tzuriel, 2000), with the Seria-Think Program by way of applying interventions taken from the mediation of processes addressed within the DA (planning and self-regulation) to the curriculum content of mathematics. Their research documents the considerable success of this approach with third grade children diagnosed with Attention Deficit Hyperactivity Disorder.

Applications in research and practice in psychopathology and developmental disabilities[3]

Given that dynamic assessment is typically used to estimate learning potential or educability (Rey, 1934), it is reasonable to ask in what ways it is relevant to the study and treatment of psychopathological conditions, which are usually associated more with emotional states than with cognitive functioning. The answer is multi-faceted, relating to at least the following aspects.

Various conditions in psychopathology and developmental disabilities are characterized by deficits in psychological abilities and intellectual performance effectiveness (e.g., schizophrenia; Hunt & Cofer, 1944; Kraepelin, 1919; Raffard, Gely-Nargeot, Capdevielle, Bayard, & Boulenger, 2009). Much of the behavioral ineffectiveness in psychiatric conditions and developmental disabilities can be attributed to cognitive inefficiency in addition to or in tandem with emotional disturbance. Dynamic assessment can reveal previously unsuspected abilities and ways to improve the cognitive performance and behavioral effectiveness of persons with psychiatric disorders and developmental disabilities (Feuerstein, 1970; Kaniel & Tzuriel, 1992). Addressing the abilities revealed by dynamic assessment and employing the strategies used to unmask them can lead to improved cognitive effectiveness, which in turn can reduce behavioral and social difficulties as well as intra-psychic conflict (see, e.g., Haywood, 2000; Haywood & Menal, 1992).

Haywood and Lidz (2007, especially pp. 49-73) have addressed these issues in detail. They observed that what appears to be loss of or failure to

3 Some of the material covered here regarding the use of dynamic assessment in research and clinical practice with persons who have psychiatric and developmental disorders was reported previously by Haywood and Lidz (2007). The discussion in the present article includes similar and more recent information.

have developed intellectual resources is instead a matter of the masking of intelligence or obstructed access to one's own intelligence. Thus, when dynamic assessment is successful in revealing learning potential, it is illogical to assume that its procedures have created intelligence where it was not before; rather, those procedures have enabled access to the intellectual resources that were present all along, by helping learners (and patients) to overcome obstacles to such access. Various authors over the last century have listed non-intellective obstacles that bar access to one's intellectual resources (Binet, 1911; Feuerstein, 1970; Feuerstein & Rand, 1974; Haywood, 2013; Rey, 1934). Such obstacles include cultural difference and cultural deprivation, impoverished language both receptive and expressive, low levels of general knowledge, inadequate motivation for learning, attention deficits, emotional disturbance, inadequate habits of thinking and learning logically, and sensory handicaps. Indeed, schizophrenia has been characterized as a "thought disorder" throughout its modern history, with the implication that it constitutes a disruption (if not destruction) of the normal processes of thinking.

In the following sections we offer examples of the utility of dynamic assessment, in both research and clinical practice in the domains of psychiatric disorders, developmental disabilities, and encephalopathy.

Research in which dynamic assessment has been used to study persons with psychiatric disorders has centered largely in the domain of schizophrenia. Because schizophrenia is characterized as a thought disorder, researchers have been interested in determining whether it is possible to distinguish identifiable patterns of thinking, especially as revealed in language structure and use.

Ever since the classic review by Hunt and Cofer (1944), it has been generally agreed, based on a growing body of evidence, that schizophrenia is characterized in large part by relatively ineffective application of intellective resources in learning and perceptual tasks as well as in everyday life. Our task in the present article is to demonstrate the utility of dynamic assessment as both research tool and clinical instrument in this domain. The concept of learning potential is useful in this regard because it implies capacity for learning that is greater than is being demonstrated in patients' behavior (Raffard et al., 2009)—a situation that fits admirably with the strategies of dynamic assessment.

Wiedl and his associates have used dynamic assessment as a research tool (see Haywood & Wingenfeld, 1992, for a discussion of DA as a research tool)

to study schizophrenia (Wiedl, 2001; Wiedl & Schottke, 1995, 2002a, 2002b; Wiedl, Wienobst, & Schottke, 2001; Wiedl, Wienobst, Schottke, & Neuchterlein, 2001; Wiedl, Wienobst, Schottke, & Kauffeldt, 1999). Carlson and Wiedl (2013) listed several domains of intellective functioning in which dynamic assessment (or learning potential assessment) has been found to be useful in efforts to understand the relation of cognition and psychopathology, especially the major psychiatric disorders such as schizophrenia. These domains include cognitive differentiation, social perception, social problem solving, communication, and skill in interpersonal interaction. Assessment in these areas of functioning feeds directly into a treatment program, the Integrative Psychotherapy Program of Brenner, Roder, Hodel, and Kienzle (1994). Given that psychological therapies are highly verbal and centered on the relation of cognitive and affective functioning, it is entirely reasonable to expect intervention of an essentially cognitive nature to be effective in altering both cognitive and affective states. Thus, dynamic assessment efforts have been focused on the thought processes of self perception, metacognition (e.g., Moritz, Veckenstedt, Randjbar, & Vitzthum, 2011), understanding of implications of one's own behavior, selective attention (Wiedl & Schottke, 1995), and predictors of rehabilitation success (Wiedl, 2001; Wiedl, Schottke, & Calero, 2001), among others.

DA has also been used to distinguish clinical subtypes in schizophrenic patients. Sclan (1986) studied chronic schizophrenic patients who were diagnosed as either paranoid or non-paranoid subtypes of schizophrenia, using Haywood'sTest of Verbal Abstracting (described by Haywood & Lidz, 2007) and Feuerstein's Representational Stencil Design Test (RSDT; Feuerstein et al., 1979. 2002). He found that (a) paranoid schizophrenic patients made fewer errors on both tests than did non-paranoid patients, (b) paranoid patients derived greater benefit from the interposed mediation in spite of having posted high pre-test scores, and (c) the two clinical subgroups could be reliably differentiated according to the types of errors they made on these tasks. DA thus aided the prognostication process and provided possibilities for therapeutic intervention in the cognitive realm.

One long series of studies has been focused on the ability of schizophrenic patients to form verbal abstractions, that is, to assign abstract meaning to events and language. Clinicians who have worked with schizophrenic patients will not fail to see the relevance of this kind of thinking. The interpretation of proverbs has been used for a century as an informal psychiatric test

with persons who suffer from psychiatric disorders, including schizophrenia. Typically, such patients do poorly on these tests, often seeming to be fixated at a concrete level of understanding. Thus, when asked "What does this saying mean: Don't cry over spilt milk?" patients with schizophrenia are likely to give concrete responses, such as "You shouldn't cry because the milk is poured out" rather than to understand the metaphorical nature of the proverb. Blaufarb (1962) showed that patients with schizophrenia significantly more often give abstract and generalized responses (e.g., "It is useless to be sorry after something is already done") when given three different statements of the proverb, that is, using three different metaphors that have the same abstract meaning, whereas the "enriched" procedure did not help the abstracting performance of persons without psychiatric disorders. Hamlin, Haywood, and Folsom (1965), using the same technique of stimulus enrichment within assessment, replicated that finding and extended the phenomenon to show that the ability to form verbal abstractions is not lost but is masked with the onset of symptoms of psychosis. The series was confirmed and extended by Haywood and Moelis (1963), who demonstrated that general intellectual performance varies as a function of the persistence of psychotic symptoms. Thus, an early form of dynamic assessment led to a change in prognostication in cases of chronic schizophrenia, if not immediately to specific treatment strategies, although clinicians were quick to adopt more effective strategies for interacting verbally with schizophrenic patients, insisting, for example, on the utility of stating relatively abstract meanings in multiple ways as well as by focusing more sharply on the use of metaphoric language and its interpretation.

A very similar dynamic assessment strategy was subsequently used in the study and treatment of persons with intellectual disabilities. Rather than using interpretation of proverbs, Gordon and Haywood employed a verbal similarities task (e.g., "In what way are an orange and a banana alike, and "In what way are an orange, a banana, a peach, a plum, and a pear alike?"). The 5-exemplar items yielded significantly higher abstraction scores than did the 2-exemplar items in persons whose intellectual disability was associated with cultural-familial circumstances but not in persons who did not have intellectual disability or in those whose disability was associated with demonstrable organic pathology. Subsequent research (e.g., Haywood & Switzky, 1974; Tymchuk, 1973) replicated these findings with different groups of intellectually low-functioning children and adolescents in different settings. The re-

search led to the development of a clinical dynamic assessment instrument, the Test of Verbal Abstracting (TVA; reported by Haywood & Lidz, 2007) that is used now in the clinical assessment of both typical individuals and persons with a variety of developmental disabilities, including autism, Prader-Willi syndrome, learning disabilities, as well as intellectual disability. The TVA is staged in such a way as to indicate either "exit" or "continue to investigate" at several points in the assessment.

Dynamic assessment is used as well in neuropsychology for assessment of the habilitation potential and promising directions for habilitative strategies in persons who have central nervous system based disabilities. Three quarters of a century ago, André Rey (1941) used an early form of dynamic assessment, notably his Plateaux Test (Rey, 1934), in the psychological examination of persons with traumatic brain injuries. The same test is incorporated, with a more obvious dynamic-mediational aspect, in Feuerstein's Learning Propensity Assessment Device (Feuerstein, Rand, & Hoffman, 1979; Feuerstein, Feuerstein, Falik, & Rand, 2002). Haywood and Miller (2003) demonstrated the use of group-administered dynamic assessment of adults with traumatic brain injuries to show that these persons improved their cognitive performances significantly with interposed mediation of cognitive and metacognitive strategies. Heinrich (1991) adapted the Halstead Category Test for dynamic administration by interposing mediation of basic cognitive and metacognitive operations between static pre-test and post-test. He then examined patients who had experienced severe head trauma, and found that they were able to derive significant benefits from the interposed mediation on tests of near transfer but were less successful on tests of far transfer, suggesting that more intensive and prolonged mediation would be required to lead to improvement in the far transfer tasks. Contrary to the prevailing pessimistic view of the likelihood of cognitive improvement in patients with severe head trauma, these two studies revealed previously unsuspected learning potential in these patients and provided bases for more prolonged therapeutic intervention. Several of Rey's tests have been translated and adapted for dynamic assessment by Haywood (see Haywood & Lidz, 2007) and are used clinically to search for rehabilitative potential in persons with traumatic brain injuries.

As we have noted previously (Haywood, 1977; Haywood & Lidz, 2007), dynamic assessment and neuropsychological assessment strategies have much in common, not least their shared goal of eliciting maximal rather than typi-

cal performance, a determination not to permit failure, and a search for cognitive strengths (what has been spared) rather than emphasizing only what has been lost. Dynamic neuropsychological assessment is one of the most promising of the various clinical applications of DA.

As is true in the case of dynamic assessment in educational settings, its use in research and practice in clinical psychology has not yet led definitively to prescriptive treatment—at least not treatments that have been empirically demonstrated. It is equally true that the groundwork has been laid for such developments; i.e., DA has allowed us to extend the knowledge base to the point that it is now possible to develop empirically the treatment strategies and programs whose basis is derived from DA of cognitive functions and their interface with emotionality and rational behavior.

Concluding thoughts and future directions

With the increasing advocacy of evidence-based procedures in the educational and clinical literature, it is clear that realization of this goal is considerably easier to say than to do. Determining and even defining what is in fact evidence is, to say the least, a considerable challenge. The good news is that there are meaningful efforts to collect and evaluate such evidence (e.g., What Works Clearinghouse at ies.ed.gov). The bad news is that there is no documentation that this information is in fact evidence for any specific individual or group that faces the teacher, therapist, or assessor at any specific time. We are unaware of any intervention or instruction that is one hundred per cent effective for one hundred per cent of the people one hundred per cent of the time. Most of us are quite pleased to find effects that are significant at the .05 level with any group-administered treatment. We suggest that such group-based evidence is only hypothetical until it is actually tried out with the individual or group to whom it is to apply. Clearly, this is too much of a burden for each and every instance, and instructional and treatment activities have to proceed in terms of probabilities of success. However, we see direct trial as necessary in the case of individuals who do not respond to the "evidence-based" interventions described in most group-based research (or even in single case studies). For individuals who do not respond, the single case, exploratory laboratory of dynamic assessment can, in our view, provide the only source of real evidence that truly closes the assessment-intervention gap. We

in fact fail to see how an assessment can be considered 'comprehensive' or how referral questions involving treatment decisions can be addressed without such information.

Standardized IQ typically predicts the criterion of academic achievement but offers no direction for instruction other than assignment to groups. These groups are hardly homogeneous in any meaningful way and are unlikely to have any simple or homogeneous response to instruction. That said, it is also true that some interventions show promise regardless of the group to which they are applied. Therefore, research needs to be double-pronged. On the one hand, there needs to be ongoing research into evidence-based practices, and, on the other hand, it cannot be assumed that any single practice will necessarily work for a specific individual. The notion of evidence needs to be rethought and broadened, with increased value (and definition of validity) assigned to prescription rather than confined to prediction. It may be necessary, but certainly not sufficient, to be able to predict future success or failure without guidelines for turning failure into success. Furthermore, as Kozulin (2013) points out, interventions need to maximize the possibility of transfer. Despite our advocacy for closing the gap between assessment and intervention, we do not propose that this gap be so tightly closed that generalizable principles and transferable strategies, the content typical of a cognitive approach to education, are neglected.

Feuerstein's work almost from the start began with both an assessment instrument (Feuerstein, Rand, & Hoffman, 1979) and a curriculum (Feuerstein, Rand, Hoffman, & Miller, 1980) designed to intervene with similar or identical functions and processes as the assessment. It would be ideal to assume that the assessment instrument is administered to determine areas of need for intervention, followed by selected instruments from the intervention to address these areas of need. In our experience and observation, this is rarely the case. All too often there is a gap or even a total disconnect, and students tend to be engaged in the entire intervention program without an attempt to make the match between areas of need and nature of prescribed interventions (e.g. review by Hadas-Lidor, Weiss, & Kozulin, 2011). Identification of areas of need and determination of the appropriate interventions are central to the closure of the assessment-intervention gap. Even among practitioners of DA, there has been too much of a reflexive response to administration of diagnostic procedures and generation of interventions. This can contribute to observations by some that DA is too time-consuming. Even de-

velopers of DA need to be concerned about issues of efficiency and specificity. The Hadas-Lidor, Weiss, and Kozulin (2011) case study demonstrates that such gap closure can be achieved with the instruments designed by Feuerstein and his colleagues.

Clearly the source of gap closure within the DA assessment process lies within the intervention portion of the assessment. Much can be achieved with a computerized adaptive approach to profile learners and their individualized responses to program content. Graduated prompts have the potential to yield instructionally relevant information, though are rarely designed to do so. Perhaps even more is available within the mediational approach to DA, which can be tailor-made for each individual, though this has its own limitations that have been well discussed in the literature. The challenge remains for researchers, developers, and practitioners to continue their efforts to "mind the gap." It is also clear from research such as that reviewed above that there has been meaningful progress toward this goal.

One document that shows promise of moving practitioners toward the goal of gap closure is the handbook by Lauchlan and Carrigan (2013). This is a very helpful, clearly written manual for educational (school) psychologists, written to lead them to and through the dynamic assessment process. The authors not only review background theory, principles, and practices, but provide a number of very practical check lists and a wide array of strategies that can provide a bridge between the assessment and instructional situations.

References

Alavi, D. M., Kaivanpanah, Sh., & Shabani, K. (2012). Group dynamic assessment: An inventory of mediational strategies for teaching listening. *The Journal of Teaching Language Skills*, 3(4), 27-58.

Baek, S-G & Kim, K.J. (2003). The effect of dynamic assessment based instruction on children's learning. *Asia Pacific Educational Review* 4(2), 189-198.

Binet, A. (1911). *Les idées modernes sur les enfants* [Modern ideas on children]. Paris : Flammarion.

Blaufarb, H. A.. (1962). A demonstration of verbal abstracting ability in chronic schizophrenics under enriched stimulus and instructional conditions. *Journal of Consulting Psychology*, 26, 471-475.

Bosma, T. (1972). *Dynamic testing in practice: Shall I give you a hint?* Doctoral thesis: University of Leiden, The Netherlands.

Brenner, H. D. Roder, V., Hodel, B., & Kienzle, N. (1994). *Integrated psychological therapy for schizophrenic patients (IPT).* Seattle, WA: Hogrefe & Huber.

Calero, M. D., Mata, S., Carles, R., Vives, C., López-Rubio, S., Fernández-Parra, A., & Navarro, E. (2013). Learning potential assessment and adaptation to the educational context: The usefulness of the ACFS for assessing immigrant preschool children. *Psychology in the Schools*, 50(7), 705-721.

Campione, J.C. & Brown, A.L. (1987). Linking dynamic assessment with school achievement. In C.S. Lidz (Ed). *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 82-115). NY: Guilford.

Carlson, J. S. & Wiedl, K. H. (2013). Cognitive education: Constructivist perspectives on schooling, assessment, and clinical applications. *Journal of Cognitive Education* and Psychology, 12, 6-25.

Carney, J.J. & Cioffi, G. (1990) Extending traditional diagnosis: The dynamic assessment of reading abilities. *Reading Psychology,* 11(3), 177-192.

Carney, J.J. & Cioffi, G. (1992) The dynamic assessment of reading abilities. *International Journal of Disability, Development and Education,* 39(2), 107-114.

Delclos, V.R., Burns, M.S., & Kulewicz, S. (1987) Effects of dynamic assessment on teacher's expectations of handicapped children. *American Educational Research Journal*, 24(3).325-336.

Delclos, V.R., Burns, M.S., & Vye, N. J. (1993). A comparison of teachers' responses to dynamic and traditional assessment reports. *Journal of Psychoeducational Assessment*, 11, 46-55.

Feuerstein, R. (1970). A dynamic approach to the causation, prevention, and alleviation of retarded performance. In H. C. Haywood (Ed.), *Social-cultural aspects of mental retardation,* 341-377. New York: Appleton-Century-Crofts.

Feuerstein, R., Feuerstein, R. S., Falik,L.H., & Rand, Y. (2002). *The dynamic assessment of cognitive modifiability : The Learning Propensity Assessment Device.* Jerusalem: ICELP Press.

Feuerstein, R., & Rand, Y. (1974). Mediated learning experience: An outline of proximal etiology for differential development of cognitive functions. *International Understanding*, 9-10, 7-37.

Feuerstein, R., Rand, Y., Y &Hoffman, M. B. (1979). *The dynamic assessment of retarded performers: The Learning Potential Assessment Device, theory, instruments, and techniques.* Baltimore, MD: University Park Press.

Feuerstein, R., Rand, Y., Hoffman, M.B. & Miller, R. (1980). *Instrumental Enrichment: An intervention program for cognitive modifiability.* Baltimore: University Park Press.

Gerber, M.M.. (2000). Dynamic assessment for students with learning disabilities: Lessons in theory and design. In C.S. Lidz & J.G. Elliott (Eds.). *Dynamic Assessment :Prevailing models and applications* [263-292]. Bingley, UK: Emerald Group.

Gordon, J. E., & Haywood, H. C. (1969). Input deficit in cultural-familial retardates: Effect of stimulus enrichment. *American Journal of Mental Deficiency*, 73, 604-610.

Guterman, E. (2010). *Metacognitive awareness and performance on assessment tasks in reading: Toward dynamic assessment of reading: Applying metacognitive awareness guidance to enhance cognitive assessment* . Saarbrücken, Germany: LAP LAMBERT Academic Publishing.

Hadas-Lidor, N., Weiss, P., & Kozulin, A. (2011). Dynamic cognitive intervention: Application to occupational therapy. In N. Katz (Ed.). *Cognition, occupation, and participation across the life span: Neuroscience, neurorehabilitation, and models of intervention in occupational therapy* (pp.323-350). Bethesda, MD: AOTA.

Hamlin, R. M., Haywood, H. C., & Folsom, A. T. (1965). Effect of enriched input on schizophrenic abstraction. *Journal of Abnormal Psychology*, 70, 390-394.

Haywood, H.C. & Lidz, C.S. (2007). *Dynamic assessment in practice: Clinical and educational applications.* Cambridge, England (UK): Cambridge University Press.

Haywood, H. C. & Menal, C. (1992) Cognitive Developmental Psychotherapy: A case study. *International Journal of Cognitive Education and Mediated Learning,* 2(1), 43-54. [Version française pp. 55-66.]

Haywood, H. C., & Miller, M. B. (2003). Group dynamic assessment with adults with traumatic brain injuries. *Journal of Cognitive Education and Psychology,* 3, 137-163.

Haywood, H. C., & Switzky, H. N. (1974). Children's verbal abstracting: Effects of enriched input, age, and IQ. *American Journal of Mental Deficiency,* 78, 556-565.

Haywood, H. C. & Wingenfeld, S. A. (1992). Interactive assessment as a research tool. *Journal of Special Education*. 26(3), 253-268.

Haywood, H.C. & Tzuriel, D. (2002). Applications and challenges in dynamic assessment. *Peabody Journal of Education,* 77(2), 40-63.

Heinrich, J. J. (1991). *Responsiveness of adults with severe head injury to mediated learning.* Unpublished doctoral dissertation, Vanderbilt University, Nashville, TN.

Hulbert, J. G. (1995). *A comparison of the usefulness of dynamic assessment reports, standard psychological reports and curriculum based assessment reports to pre-school teachers in designing instruction for young children with disabilities.* Dissertatioin Abstracts International Section A: Humanities & Social Sciences, 56 (6-A), 2173. Doctoral Dissertation, Cleveland State University, 1995.

Hunt, J. McV., & Cofer, C. N. (1944). Psychological deficit. In J. McV. Hunt (Ed.), *Personality and the behavior disorders*, 971-1032. New York: Ronald Press.

Jeltova, I., Birney, D., Fredine, N., Jarvin, L., Sternberg, R. J., Grigorenko, E. L. (2011).Making instruction and assessment responsive to diverse students' progress: Group-administered dynamic assessment in teaching mathematics. *Journal of Learning Disabilities*, 44(4), 381-395.

Kaniel, S., & Tzuriel, D. (1992). Mediated learning experience approach in the assessment and treatment of borderline psychotic adolescents. In H. C. Haywood & D. Tzuriel (Eds.), *Interactive assessment*, 399-418. New York: Springer.

Karpov, Y. (2008). Do all dynamic assessment techniques assess learning potential? *Journal of Cognitive Education and Psychology*, 7, 411-418.

Kraepelin, E. (1919). *Dementia praecox*. New York: Churchill Livingstone, Inc.

Lantolf, J.P. & Poehner, M.E. (2006). *Dynamic assessment in the foreign language classroom: A teacher's guide*. University Park, PA: Center For Advanced Proficiency Education and Research (CALPER). [149 pp and Video DVD: version 1.0]

Lantolf, J.P. & Poehner, M.E. (2010). Dynamic assessment in the classroom: Vygotskian praxis for second language development. *Language Teaching Research*, 15(1), 11-33.

Lauchlan,, F. & Carrigan, D. (2013). *Improving learning through dynamic assessment*. Jessica Kingsley: London.

Lidz, C.S. (1991). *Practitioner's guide to dynamic assessment*. NY: Guilford.

Lidz, C.S. (2014). Leaning toward a consensus about dynamic assessment: Can we? Do we want to? *Journal of Cognitive Education and Psychology*, 13 (3), 292-307

Lidz, C.S. & Greenberg, K.H. (1997). Criterion validity of a group dynamic assessment procedure with rural first grade regular education students. *Journal of Cognitive Education*, 6 (8), 89-99 .

Lidz, C.S., Jepsen, R.H., & Miller, M.B. (1997). Relationships between cognitive processes and academic achievement: Application of a group dynamic assessment procedure with multiply handicapped adolescents. *Educational and Child Psychology*, 14, 56-67.

Lidz, C.S. & Macrine, S. (2001). Identification of minority and immigrant students for gifted education: The contribution of dynamic assessment. *School Psychology International*, 22 (1), 74-96.

Moritz, S., Veckenstedt, R., Randjbar, S., & Vitzithum, F. (2011). MKT: *Individualisiertes Metakognitives Therapieprogramm für Menschen mit Psychose* [MKT: Individualized metacognitive training program for opersons with psychosis]. Berlin: Springer.

Peña, E.D. & Gillam, R.B. (2000). Dynamic assessment of children referred for speech and language evaluations. In C.S. Lidz & J.G. Elliott (Eds.). *Dynamic assessment: Prevailing models and applications* (pp.543-575). Bingley, UK: Emerald Group Publishing Ltd (Elsevier Science).

Petersen, D.B., Allen, M.M. & Spencer, T.D. (2014). Predicting reading difficulty in first grade using dynamic assessment of decoding in early kindergarten: A large-scale longitudinal study. *Journal of Learning Disabilities,* 18.

Poehner, M.E. & van Campernolle, R.A. (2011). Frames of interaction in dynamic assessment: Developmental diagnoses of second language learning. *Assessment in Education: Principles, Policy, and Practice,* 18(2), 183-198.

Raffard. S. Gely-Nargeot, M.-C., Capdevielle, D., Bayard, S., & Boulenger, J.-P. (2009). Potentiel d'apprentissage et revalidation cognitive dans la schizophrénie [Learning potential and cognitive remediation in schizophrenia]. *L'Encéphale*, 35(4), 353-360.

Rey, A. (1934). D'un procédé pour évaluer l'éducabilité Quelques applications en psychopathologie. Archives de Psychologie, 24, 96. English translation H. C. Haywood (2012), A method for assessing educability : Some applications in psychopathology. *Journal of Cognitive Education and Psychology,* 11, 274-300.

Rey, A. (1941). L'Examen psychologique dans les cas d'encéphalopathie traumatique [Psychological examination in cases of traumatic brain injury]. *Archives de Psychologie*, 28, 112.

Schevel, E-M. (2008). *Adaptation der "Application of Cognitive Functions Scale (ACFS)" für den deutschen Sprachraum.* Unpublished thesis, Universität Osnabrück

Sclan, S. G. (1986). *Dynamic assessment and thought disorder in paranoid and nonparanoid schizophrenic patients.* Unpublished doctoral dissertation, Vanderbilt University, Nashville, TN.

Stevenson, C.E., Bergwerff, C.E., Heiser, W.J. & Resing, W.C.M. (2014). Working the dynamic measures of analogical reasoning as predictors of children's reading and math achievement. *Infant & Child. Development* 23, 51–66.

Stevenson, C.E., Heiser, W.J. & Resing, W.C.M. (2013). Working memory as a moderator of training and transfer of analogical reasoning in children. *Contemporary Educational Psychology* 38, 159–169

Stevenson, C.E. , Hickendorff, M., Resing, W.C.M., Heiser, W.J., & de Boeck, A.L.P. (2013). Explanatory item response modeling of children's change on a dynamic test of analogical reasoning. *Intelligence* 41, 157–168.

Teo, A. (2012). Promoting EFL students' inferential reading skills through computerized dynamic assessment. *Language Learning & Technology* 16 (3), 10–20.

Tzuriel, D. (2000). The Seria-Think Instrument: Development of a dynamic test for young children. *School Psychology International,* 21, 177-194.

Tzuriel, D. & Trabelsi, G. (2014). The Effects of the Seria-Think Program (STP) on Planning, Self-Regulation and Math Achievements among Grade 3 Children with Attention Deficit Hyperactivity Disorder (ADHD). In Papadopoulos, T. C., Parrila, R. K., & Kirby, J. R. (Eds.). *Cognition, intelligence, and achievement: A tribute to J. P. Das.* (pp. 345-367). San Diego, CA: Academic Press.

Van der Aalsvoort, G. M. & Lidz, C S. (2007). A cross-cultural validation study of the Application of Cognitive Functions Scale: A dynamic assessment procedure, with Dutch first grade students from regular primary schools. *Journal of Applied School Psychology*, 24(1), 291-108.

Wiedl, K.H. (2001). Dynamic assessment of cognitive rehabilitation potential in schizophrenic persons and in elderly persons with and without dementia. *European Journal of Psychological Assessment*, 17(2), 112-119.

Wiedl, K.H. & Schottke, H. (1995). Dynamic assessment of selective attention in schizophrenic subjects: The analysis of intraindividual variablility of performance. In J.S. Carlson (Eds.). *Advances in cognition and educational practice: European contributions to dynamic assessment* (volume 3; pp. 185-203). Greenwich, CT: JAI Press.

Wiedl, K.H.& Schottke, H. (2002a). Vorhersage des Erfolgs schizophrener Patienten in einem psychoedukativen Behandlungsprogramm durch Indikatoren des Veranderungspotentials im Wisconsin Card Sorting Test (Predicting schizophrenic patients' proficiency in a psychoeducation treatment program with the help of indicators of potential for change in the Wisconsin Card Sorting Test.). *Verhaltenstherapie,* 12, 90-96.

Wiedl, K.H. & Schottke, H. (2002b). Ein modell zur Vorhersage des Rehabilitationserfolgs schizophrener Patienten (A prediction model for schizophrenic patients' success in rehabilitation). Vortrag auf der 43. Tagung der Deutschen Gesellschaft für Psychologie in Berlin (Paper presented at the 43rd conference of the German Association of Psychology, Berlin).

Wiedl, K.H., Schottke, H., & Calero, M.D. (2001). Dynamic assessment of cognitive rehabilitation potential in schizophrenic persons and in elderly persons with and without dementia. *European Journal of Psychological Assessment,* 17(2), 112- 119.

Wiedl, K.H., Wienobst, J., & Schottke, H. (2001). Estimating rehabilitation potential in schizophrenic subjects. In H.D. Brenner, W. Boker, & R Genner (Eds.). *The treatment of schizophrenia-status and emerging trends* (pp. 88-103). Bern: Hogrefe & Huber.

Wiedl, K.H., Wienobst, J., Schottke, H., Green, M.F., & Neuchterlein, K.H. (2001). Attentional characteristics of schizophrenic patients differing in learning proficiency in the Wisconsin Card Sorting Test. *Schizophrenia Bulletin,* 27 (4), 687-695.

Wiedl, K.H., Wienobst, J., Schottke, H., & Kauffeldt, S. (1999). Differentielle Aspekte kognitiver Remediation bei schizophren Erkrankten auf der Grundlage des Wisconsin Card Sorting Test [Differential aspects of cognitive remediation with schizophrenic persons using the Wisconsin Card Sorting Test.] *Zeitschrift für Klinische Psychologie, 28*(3), 214-219

Wiedl, K.H., Mata, S., Waldorf, M. & Calero, M.D. (2014). Dynamic testing with native and migrant preschool children in Germany and Spain using the Application of Cognitive Functions Scale. *Learning and Individual Differences,* 35, 34–40

Effects of schooling on level of cognitive functioning and analogical reasoning modifiability

JÁNOS RÉKA [1]

Abstract

Examination of cognitive development of children has centered on performance testing. Less attention has been paid to learning potential measurements. In this paper we will present two studies focusing on relationship between chronological age, schooling and analogical reasoning.The aim of Study 1 was the delimitation of the effect of a year of schooling on the increase of analogical reasoning operation level from the effects of chronological age. In the specialty literature written on this topic there are contradictory data regarding schooling effects on performance in tests that measure the psychometric g. The aim of study 2 was to check the role of schooling, level of schooling and chronological age in determining the modifiability of analogical reasoning. The results show a major effect of schooling on metacognitive planning and a medium effect on analogical reasoning operational and functional level.

Keywords

Analogical reasoning, schooling, modifiability, metacognitive strategies, children 7-11 year

In the research of the relationship between the brain's biological maturity and learning there is a major dilemma regarding the role these factors play in cognitive development (Piaget, 1947/2001, Vygotsky, 1978). According to Piaget (1947/2001) the cognitive development of cognitive processes is the result of biological maturization. In Vygotsky's point of view cognitive development is primarily determined by social interactions. Feuerstein represents a third force in this debate with his cognitive modiafiability theory. He was involved in the psychological assessment of immigrant children in Israel and found that children from different cultures perform very low on classic psychomet-

1. Babes-Bolyai University, Cluj-Napoca, Correspondence: reka.janos@ubbcluj.ro

ric tests. Influenced by Piaget and Vygotsky's work Feuerstein reformulated the traditional view of intelligence and began to develop a more dynamic approach to evaluating children's cognitive functioning. The central concept of Feuerstein's theory is structural cognitive modifiability (Feuerstein, 1979, 1980) which "describes the unique propensity of human beings to change or modify the structure of their cognitive functioning to adapt to changing demands of life situations"(Feuerstein, Feuerstein snd Falik, 2008, p. 2).

This determination transposed into the topic of research of reasoning and analogical transfer can be formulated as follows: they are developed according to the age of children or are related to formal education, i.e. to participation in an act of formal education. A second question refers to the modifiability of functioning level of analogical reasoning after a "mini period of schooling" according to Feuerstein's Structural Cognitive Modifiability theory.

Comparative studies of schooled and unschooled children show major differences between the two groups as far as their cognitive performance shown in the solution of tasks of analogical reasoning is concerned. The mechanisms which explain these differences are different and often of qualitative nature (Tulviste, 1991, Vygotskij, 1971, 1972).

A number of researches (Ceci, 1991; Winship and Korenman, 1997; Hansen, Heckman and Mullen, 2003) demonstrate that performance of children in psychometric tests show a linear increase with the levels of schooling. This linear correlation does not answer the question whether the age or the effect of schooling result in an increase of performance on the tests of intelligence, as the age of children also increases linearly with the level of schooling.

For the purpose of delimiting age effects from schooling effects, Cahan and Cohen (1989) have separated the two variables and demonstrated that schooling has an effect almost double as compared to age. This result has subsequently been confirmed by other studies (Crone, Whitehurst, 1999; Stelzl, Merz, Ehlers, Remer, 1995).

Several studies assess the actual consequences of schooling, by comparing the effects of chronological age and educational level. Brouwers, Mishra and Van der Vijver (2006) show that the operational level of intelligence in children increases by the acquisition of operations (e.g. grouping, conservation, etc.), by manipulating objects and symbols. The difference between schooled and unschooled children can also be explained by the general operational level, i.e. the psychometric g. (Case, Demetriou, Platsidou, Kazi, 2001).

Knowledge acquired in school results in a qualitative leap in the operational level of children (Vygotsky, 1971, 1972); although daily experiences contribute to the accumulation of cognitive operations, they cannot compensate for the effects of schooling. Schooling helps children develop skills in applying cognitive operations via the learning of some strategies and the use of certain cognitive tools which amplify transfer performance.

The role of formal education in the development of problem solving strategies has formerly been demonstrated (e.g., Posner, 1982) but their limits of applicability are not well outlined. Schooling creates its own domain of strategic knowledge (Lave, 1997), but this knowledge has an applicability limit. For example, Liberian adults, who have attended school, performed more weakly in navigation tasks based on numeric abilities than unschooled Liberians, which means that school develops strategies which do not induce transfer to tasks belonging to different fields.

Herrnstein and Murray (1994) after reviewing the literature showed that the differences between schooled and unschooled children cannot be explained exclusively by variations in intellectual factors. They suggests that IQ level increases with one point in each school year. An increase in the level of intelligence has been demonstrated by other studies as well. Winship and Korenman (1997) have reviewed these data and have obtained an effect estimated at 2.7 point IQ for each year of schooling. In conclusion, all studies in this domain indicate an increase between 1 and 4 IQ points/ school year.

In more recent studies effects of chronological age, educational level and socio-economic status on performance shown in formal tests or tests that contain items derived from real life situations are calculated both separately and in interaction (Christian et al., 2001; Sternberg et al., 1993). Brouwers, Mishra, Van de Vijver (2006) have assessed the role of these factors in a series of experiments with children from India.

They examined schooled and unschooled children with ages ranging between 6 and 9 years, using formal tests as well as tests containing items related to everyday tasks. No significant differences have been demonstrated between schooled and unschooled children in the administred tests. Their conclusion is that the level of education is not more predicitive than chronological age concerning individual differences.

Children have had significantly better results in tests containing real life situations than in formal tests and discrepancy between schooled and unschooled children has been significantly smaller in situational tests than in

formal tests. Further on, they have demonstrated a significant and powerful relationship between chronological age and the g factor, but the level of schooling does not correlate with psychometric *g*. The combining of effects of factor g, of schooling level and socio-economic status had a predictive value of 81% in the variance of crystallised intelligence.

With the use of covariance analysis, the authors have demonstrated a significant effect of chronological age on test results, rather than on Raven analogical reasoning test. Calculating the size of effect for each variable they reached the conclusion that chronological age had an effect almost double as compared to the effect of educational age.

Contradictory results have been obtained by Cliffordson and Gustafsson (2008). By using the method of regression analysis to delimit the schooling effect from chronological age effects on intellectual performance, they have examined a large number of participants with tests which affect Fluid Intelligence (GF), Crystallized Intelligence (GC) and General Visualization (GV). The results have highlighted a lesser effect of chronological age in comparison with that of educational level. These results are in accordance with the results of Winship and Korenman (1997) and demonstrate that both chronological age and the level of education increase intellectual performance, with the exception of tests that measure fluid intelligence (GF) for which the age has an inverse effect.

Other studies (e.g. Helms-Lorentz, van de Vijver, Poortinga, 2003, Van de Vijer, Brouwers, 2009) have examined the relationship between chronological age, educational age and schooling, and their effect on the processing speed of information. Performances have been measured by using a computerized test batteries and the Raven test. Chronological age and educational age represented a significant predictive value for all the tests. Thus, the two indicators of age have shown the same relation with cognitive tests but interaction between them did not result in a significant correlation. The conclusion that can be drawn based on these results is that schooling does not have a stronger impact on solving speed and results than natural environment. This can be explained by the nature of tests that use a "culture-free" content, i.e. independent of culture. These results being inconsistent with most previous research, the authors are trying to explain such discrepancies by the quality of education in the region participants originate from.

Returning to the questions at the beginning of the study, we formulated the following objectives. The aim was the delimitation of the effect of a year

of schooling on the increase of analogical reasoning operation level from the effects of chronological age. In the literature written on this topic there are contradictory data regarding schooling effects on performance in tests that measure the psychometric *g*.

If performance in culture-free analogies tests does not increase linearly with educational age, it means that schooling has a more metacognitive rather than cognitive effect, more precisely children learn strategies for planning, approach and relationing of problems.

Study I

Hypothesis

Schooling (the integration in a system of formal education) has a greater effect on the efficiency of analogical problem solving than the level of education.

Participants

In order to avoid methodological mistakes we have used severe selection criteria in the selection of participants: all participants to originate from the same country, to be of the same age, presence of children who do not attend school at all, inclusion of children with regular as well as occasional attendance. Testing took place in May so as to avoid decrease in performance due to the long holidays.

A population of 70 children aged between 7-11 years (M=8.32, sd=2.59) participated in the study). The children were divided into 3 groups on the basis of their schooling experience: 6 unschooled children, 30 children schooled on occasional basis and 34 children schooled on regular basis. Groups were balanced according to the criteria of age and sex. (Table 1).

Group of unschooled children. It contained a number of 6 children, who live in the suburbs of Cluj known as Pata RÂt. These children live near the garbage dump of Cluj in very difficult conditions. Some of them are enrolled in schools but do not attend classes. Some of the children did not know their last name or their age. Data regarding their age have been obtained from

their parents. In some cases not even the parents could give a precise answer to this question.

Group of participants schooled occasionally Children in this group are helped by the Caritas Foundation in Cluj; although they are engaged in formal education they do not regularly attend school.

Group of participants schooled regularly. They come from primary schools in Cluj-Napoca. Their socio-economic status is very varied.

Table 1.
Demographic data of participants *

	Age				
Schooling	*7-8*	*8-9*	*9-10*	*10-11*	Total
Unschooled	2	2	2	----------	6
	(1, 1)	(0, 2)	(1, 1)		(2, 4)
Occasional	8	7	7	8	30
schooling	(3, 5)	(3, 4)	(3, 4)	(3, 5)	(12, 18)
Regular	10	8	8	8	34
schooling	(6, 4)	(5, 3)	(4, 4)	(4, 4)	(19, 15)
Total	22	17	18	16	70
	(10, 10)	(8, 9)	(8, 9)	(7, 9)	(33, 37)

* Number of boys and girls appears in parenthesis

Instruments

In this study we used the Matrix Analogy Test (MAT) by J. A. Naglieri

The test is used to assess nonverbal intelligence and inferential reasoning in pupils aged between 5 and 17 years. Test items are grouped according to four factors which build up nonverbal intelligence: Completion of Patterns, Analogical Reasoning, Serial Reasoning and Spatial Visualization.

Procedure

The test has been administered individually and lasted approximately 30-50 minutes for each participant. Assesments have taken place during the month of May, 2013. Tests have been administered by 3 experienced assessors.

Results

Results are presented in two stages. In the first stage we present descriptive statistics; in the second stage, the results concerning differences between groups and the effect of chronological age, educational age and that of schooling on the results obtained by the participants in MAT subtests. (Table 2.).

Table 2.
Descriptive statistics of participants

Variable	N	Min.	Max.	M	SD
Pattern Completion	70	,00	16,00	10,00	4,94
Analogical Reasoning	70	,00	15,00	7,25	4,63
Serial Reasoning	70	,00	16,00	8,37	5,45
Spatial Visualization	70	,00	14,00	3,85	4,02

From results shown in Table 2, it is apparent that there were participants who have resolved none of the items of the MAT test and there are children who have solved all the items. For a result in greater detail see Table 3.

Table 3.
Averages and standard deviations of the 3 groups

	Schooling	N	M	SD
Pattern Completion	1	6	2,50	2,42
	2	30	7,40	4,15
	3	34	13,61	2,26
Analogical Reasoning	1	6	2,00	2,28
	2	30	4,73	3,93
	3	34	10,41	3,06
Serial Reasoning	1	6	,50	,836
	2	30	6,16	4,79
	3	34	11,70	3,84
Spatial Visualization	1	6	1,50	1,64
	2	30	1,60	2,19
	3	34	6,26	4,19

1 = Unschooled; 2 = Ocasionally schooled; 3 = Regularly schooled

In every subtest schooled children obtained the best results, followed by children with occasional schooling while the poorest results were obtained by unschooled children.

In order to delimit the effect of each variable taken into account (schooling, chronological age, educational age), in a second stage of data processing the multiple regression method was used (Table 4). Chronological age, educational age, and schooling explain 66.7 % of result variancy on the Pattern Completion subtest, 47.2 % of result variancy on the Serial Reasoning subtest, 46.1 % for the Analogical Reasoning subtest and only 26.8 % for the Spatial Visualization subtest.

Table 4.
Effects of schooling, chronological age and educational level on MAT performance

Subtests	Factors	*B*	p
Pattern completion			
	Schooling	0,712	,000
	Level of schooling	0,175	,155
	Age	0,174	,129
Analogical reasoning			
	Schooling	0,585	0,000
	Level of schooling	0,216	0,169
	Age	-0,025	0,086
Serial reasoning			
	Schooling	0,536	0,000
	Level of schooling	0,305	0,051
	Age	-0,054	0,706
Spatial visualization			
	Schooling	0,602	0,000
	Level of schooling	-0,159	0,384
	Age	0,047	0,779

Schooling variable (Table 4.) has a significant effect on the results of analogical reasoning subtests. There are no significant effects of age and schooling level on the results of the 4 subtests.

To highlight the effects of schooling level on test performance a multivariate ANOVA analysis was conducted. We found significant differences between groups delimited by the level of schooling (CP, $F(3, 66)=17.32$, $p=0.000$, RA $F(3, 66)=8.82$, $p=0.000$, RS $F(3, 66)=13.32$, $p=0.000$, VS $F(3, 66)=3,43$, $p=0.022$).

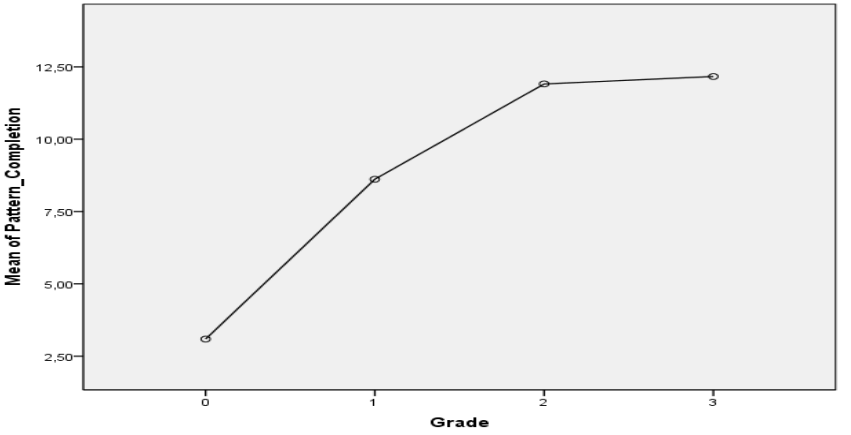


Figure 1. The effect of schooling level variable in the Pattern Completion subtest

In CP and RA subtests children's performance increases linearly with the level of schooling (Figure 1 and 2). In pattern completion one may notice a considerable increase in performance of unschooled children up to second grade. There is no indication of such a significant increase between second graders and third graders.

In the analogical reasoning subtest the greatest difference can be found between unschooled children and first graders. After this leap, no significant developments were recorded in relation to educational level.

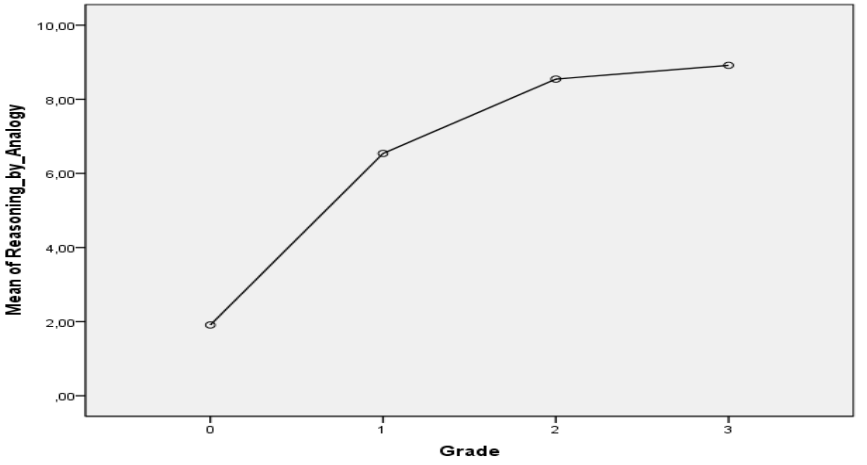


Figure 2. The effect of education level variable on Analogical reasoning subtest

In the Serial Reasoning subtest there is a tendency of performance increase in unschooled children up to second grade, but between second and third grades a tendency of decrease is to be noticed (Figure 3).

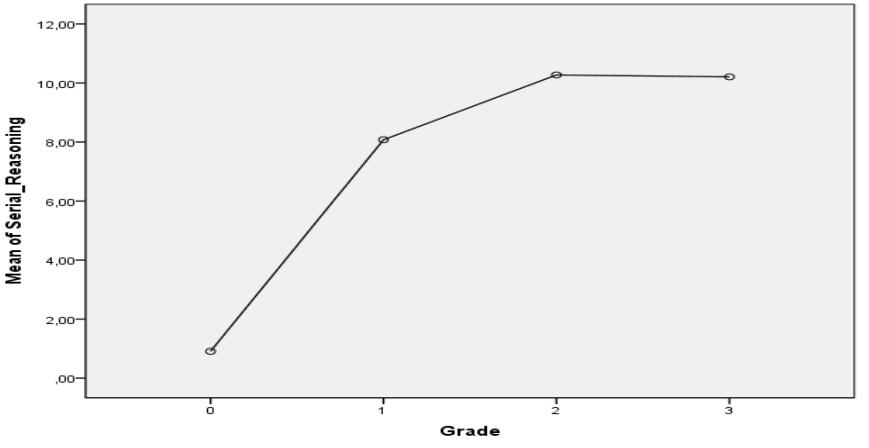


Figure 3. The effect of education level variable at the Serial Reasoning subtest

In the Spatial Visualization subtest an even more pronounced decrease is observed, third graders had a significantly poorer performance than participants from the second grade. (Figure 4).

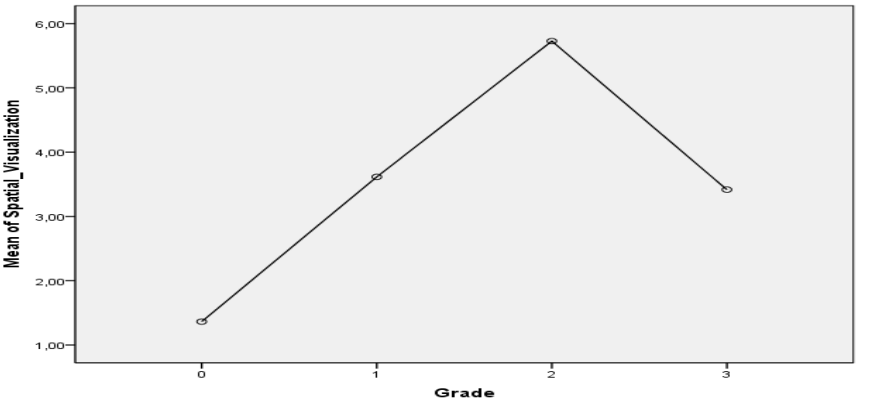


Figure 4. The effect of schooling level variable in the Spatial Visualization subtest

Discussions

This study tried to delimit the influence of schooling and schooling level on performance in tasks based on analogical reasoning. By identifying these factors, the aim was to clarify the role of schooling in analogical reasoning performance and by this, to elucidate the role that metacognitive components play in solving analogies.

In previous studies (Helms-Lorenz, van de Vijver, Poortinga, 2003, van de Vijver, Willemse, 1991) only a minimal influence of schooling on cognitive performance measured with psychometric tests has been demonstrated. According to our results, the fact that a child attends school regularly, occasionally or does not participate at all in formal education creates significant differences on the level of analogical reasoning. Schooling effect is more powerful than the effect of age or level of schooling. The results are in accordance with the results obtained by Fuller and Clarke (1994) and Brouwers et al. (2006).

As expected, our findings confirm previous experimental data (Cahan, Cohen, 1989; Stelzl, Merz, Ehlers and Remer, 1995, Crone, Whitehurst, 1999) having a new methodological characteristic: the participants in the experiment come from the same locality and their age is balanced. Also, there have been found children aged 10-11, who have not yet participated in a formal system of education.

Starting from these findings, several conclusions can be drawn in what concerns the components of analogical reasoning. In the first place, the importance of metacognitive strategies involved in solving analogies may be emphasized. The learning of these strategies is linked to formal education and may not be compensated for by children's daily experiences.

School helps children in acquiring higher level thinking strategies, these acting on a metacognitive level - since the level of education did not have a significant effect. If there is a general level of efficiency linked to maturization of the cognitive system, then age should also have had a significant effect on solving tasks of analogy.

The obtained data show that children's performance in tests that contain tasks of analogy does not increase linearly with chronological age. In the case of certain tasks of analogy even a decrease of performance was noted. These results lead to the idea that cognitive maturization in itself does not guarantee good performance in recognizing and solving analogies, unless they are regulated by metacognitive factors. We do not want to deny the existence of analogical thinking in unschooled children, we have even noticed in the interactions before and after tests that they use analogies to explain certain events, but not as a systematic approach to the problems, a strategy constantly used by schooled chilren.

The combined effect of schooling, age and level of schooling on different types of problems proved to be different. In the case of easier tasks based on analogical reasoning, like pattern completion, schooling proved to have had the largest influence. In tasks based on serial thinking and spatial visualization we found the smallest influence. The ability to discover the order in which items appear in a matrix and the ability to imagine what a figure will look like when two or more components are combined is more accessible to children with a low level of education, i.e. children from first or second grade.

In accordance with Ceci (1991) and Christian et al. (2001) schooled children do better in tests of basic intelligence and it could seem to us that those with lack of schooling are less intelligent. These differences, however, are not

based on a different functional level but on the lack of metacognitive strategic knowledge.

Results presented here have several limits. The greatest shortcoming is the very small number of unschooled children. Unfortunately from the viewpoint of scientific results, but fortunately for the Cluj Napoca society, it is very difficult to find children who totally lack schooling. Another limitation of the research is the inadequate conditions in which the tests were given.

For a more accurate delimitation of the influence of schooling, age and educational level we conducted another experiment.

Study II

The findings of Study I made it necessary to check the role of the variables level of schooling, schooling and chronological age in determining reasoning modifiability. The test used in this study is much more practical and in this way, resembles the tests with integrated content in everyday tasks (Brovers, Mishra and van de Vijer, 2006). Previous studies failed to show significant differences between schooled and unschooled children in these conditions. The Children Analogical Thinking Modifiability Test (CATM) has several advantages over other analogical tests: first, it allows the manipulation of objects, and as such, may be included in the category of the paradigm "learning by doing". Another advantage of the test is given by the structure of the item: it allows the measuring of current operation level of analogical reasoning as well as the measuring of the size of analogical transfer made between the learning and the post-test phase.

Returning to the initial question about the modifiability of functioning level of analogical reasoning after a “mini period of schooling” according to Feuerstein’s Structural Cognitive Modifiability theory we administrated the Children Analogical Modifiability test for a more accurate radiography of metacognitive strategies involved in solving analogies.

Hypothesis

As far as tests aimed at solving analogies are concerned, after a period of training/learning schooling effect does not occur on a significantly high level as in the case of formal tasks, but it is a positive predictor of the transfer coefficient.

Participants

Table 5.
*Number of participants/age and schooling**

Schooling	*7*	*8*	Total
Unschooled	4	8	12
	(1,3)	(4, 4)	(5,7)
Regularly schooled	10	13	23
	(6, 4)	(7,6)	(13, 10)
Total	14	21	35
	(7, 7)	(11, 10)	(18, 17)

* Number of boys and girls appears in parenthesis

Instruments

We used the Children`s Analogical Thinking Modifiability Test elaborated by D. Tzuriel and P. Klein (1985).

The primary objective of the Analogical Reasoning Modifiability test is to assess the ability of training and using of abstract concepts and cognitive processes which operate on the abstract relations between them within the framework of analogical reasoning and transfer. The test contains three sets of logically isomorphic non-verbal analogies. Each set contains 14 analogies applied during three stages: pre-learning, formative learning and post-learning stages.

Pre-learning phase has several objectives. The main objective is the assessment of participants' basic level of cognitive functioning by examining their ability to recognize, elaborate and use non-verbal analogies. Pre-

learning stage also aims at familiarizing participants with elements of tasks included in the terms of analogies (shape, colour, size), as well as practising modalities of correct answer elaboration within the first tasks.

Procedure

The 3 series of analog isomorphic problems have been individually administered. Administering pretest lasted for approximately 15 minutes for each participant. Learning phase took much longer in unschooled children (approximately 1 hour and 20 minutes), schooled children assimilated solving strategies in 15-20 minutes. The posttest took place immediately after the learning phase and lasted on average (regardless of group) 10-20 minutes. Having to take into account the criteria imposed by us, testing took place during May and June (so as not to be applied after a long holiday).

Three experienced pscychologists collected data, each of them having a more than three-year experience in administering formative tasks.

Results

In the first phase, we calculated averages and standard deviations for each group and each test phase (pre- and posttest). (Table 6).

Table 6.
Averages and standard deviations obtained by the two experimental groups in the CATM test

	Pretest								Posttest							
	Schooled				Unschooled				Schooled				Unschooled			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
Rez. CATM	9.7	3	4	13	5.6	1.8	3	9	13	0.8	11	14	7.8	3.3	3	14

We also calculated the transfer coefficient using the formula: xmax-xpost/xpost-xpre where xmax means maximum achievable points in the test (14 points in this case), while xpre and xpost scores obtained by participant in the pretest and posttest phase.

Table 7.
Averages and standard deviations of transfer coefficient

	Transfer Coefficient			
	Schooled (N=12)		Unschooled (N=23)	
	M	SD	M	SD
CATM	0.31	0.30	0.68	0.29

In order to test the hypotheses we used the multiple regression method in which we introduced age, level of schooling and schooling as independent variables, and performance in pre- and posttest and transfer coefficient as dependent variables. (Table 7)

Table 8.
Regression analysis

Variable	Pretest			Posttest			Transfer		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Schooling	2.31	1.88	1.12	5.76	1.50	0.87*	0.73	0.21	1.01**
Level of schooling	0.96	1.18	0.24	-0.50	0.94	-0.13	-0.25	0.13	-0.59
Age	1.43	0.89	0.24	0.55	0.71	0.09	0.03	0.10	0.06
Schooling x Level of Schooling x age									
R^2			0.45			.62			.34
F			8.78**			17.26**			5.41**

*p < .05. **p < .01.

In the pretest phase the minimum score obtained by participants from the unschooled group was 3 points and 4 points in the experimental group of "schooled" children. In the group of unschooled children no participant obtained maximum score in the pretest stage. Participants from the "schooled" group who obtained maximum score in the pretest phase were excluded from the experiment because they do not show progress after the learning phase.

With respect to the coefficient of transfer only one child out of those unschooled obtained 0 points, i.e. score did not increase in posttest phase as compared to the prettest. In the group of schooled children 3 children had transfer coefficient 0.

After processing the data, interesting results were obtained. Variation in the current operation level of analogical reasoning (pretest), measured with practical tests is explained in 45% by the cumulative effect of schooling, level

of schooling and age. We found that the influence of variables included in the experiment was the greatest in the posttest phase (after the learning phase). At this stage of analogies solving, 62% of result variancy can be explained by the factors of schooling, level of education and age. The transfer coefficient is influenced in 34% by the cumulative effects of schooling, level of schooling and age.

The highest scores in both pretest and post-test phase were obtained by schooled children ($F(2, 32) = 8.78$, $p<0,001$ pretest phase, respectively $F(2, 32) = 17.26$, $p<0,001$ in post-test phase). The transfer coefficient of schooled children was significantly higher than that of unschooled children ($F(2, 32) = 5.41$, $p<0,001$.

After calculating the influence of each predictive factor it was noted that only schooling had a significant effect on post-test performance and on transfer coefficient (Table 8)

In the next stage differences between schooled and unschooled children's results in pretest and post-test were tested by using the method of variance analysis in repeated measurements. The main effect of test phase is significant, Wilk's Lambda=0.45, $F(1, 34) = 39.79$, $p=0,000$. Interaction between test phase (pretest and posttest) and schooling variable was not significant Wilk's Lambda=0.95, $F(1, 34) = 1.51$, $p=0,227$. Schooling had a significant effect ($F(1, 34) = 41,60$, $p=0,000$ on pre- and post-test performance.

Following this, the difference between unschooled children's averages obtained in pre- and posttest ($t=4.73$, $p=0,001$) were calculated.

Discussions

The purpose of the study was a more accurate radiography of the metacognitive component which is an important mechanism of both analogical reasoning and analogical transfer. The CATM test was used which has several advantages over formal tests. First of all, test items are not presented to children, they can only be rebuilt by figuring out and by objects that can be easily manipulated by participants. Secondly, the test also includes a learning phase which can be regarded as an educational activity in which strategies of metacognitive approach, planning and self-monitoring are offered.

According to the findings, neither age, nor schooling and nor the level of schooling had a significant effect on solving analogies (pretest phase) meas-

ured by formative tests. This means that differences between children are not based on these factors but are determined by variables not included in our research (e.g. level of intelligence, the *g* factor, etc.) This record is an argument for inter-cultural studies in which the effect of test content on performance has been demonstrated. Taking into account children's culture, major differences in results have been reduced (Berry et al. , 2002, Irvine, 1979, van de Vijer, 2002). Manipulation of objects, which is equivalent to both schooled and unschooled children's daily experiences (Piaget, 1947/2001) is the engine of cognitive operation development and in this way these are not affected by chronological age, schooling and level of schooling as Vygotskij (1971, 1972) suggested.

The findings highlight the role of schooling which has a significant influence on transfer coefficient and posttest results. Schooled children had better results in each testing stage (pre- and posttest) than unschooled children but only the after learning phase results were influenced by schooling. These results lead us to believe, that the learning phase managed to create a "mini period" of schooling but this only takes effect if it cumulates with regular attendance of a formal educational system. Direct comparison of analogical skills emphasized the role of schooling which has substantial impact on the results of the posttest. Schooled children took more advantage from induction of metacognitive strategies. Thus, the results obtained are in accordance with Posner's (1982) findings: schooling induces the use of strategies without affecting the operational level of children.

According to Feuerstein (1979, 2008) after a short period of mediation we found changes in efficiency of analogical reasoning functionality depending of complexity of tasks. Despite the fact that no statistically significant differences were found between pre-test and post-test results of unschooled children a change in their problem approach and higher-order intellectual acts can be observed.

This result was also confirmed by comparing transfer coefficient in experimental groups. It was proved that even relatively short periods of schooling have a big impact on children's cognitive functioning (Fuller and Clarke, 1994). School broadens the field of applicability of thinking but does not create new operational processes (Brouwers et al., 2006). School's role is, therefore, not to create new intellectual structures, and it has to centre on ensuring success in transferring the knowledge children have acquired (Cole and

Bruner, 1971). Such knowledge transfers can be achieved by using metacognitive strategies such as approach, planning and self-monitoring.

Conclusions

The benefficial effect of schooling appears in the manner in which children can transfer knowledge. Analogical transfer (recognition of similarity, mapping and application of knowledge in new situations) is influenced by the metacognitive strategies learned in schools.

Chronological age and educational level do not have a significant impact on the operational level of analogical reasoning and transfer. Even a short-term schooling will result in development of metacognitive strategies which increase the operational level of analogical reasoning (Castillo, 1998). Important components of analogical reasoning and transfer are those metacognitive strategies which are taught in schools and help both in solving analogical tasks and in knowledge transfer.

Limitations of the study

A real limit of the study is the very small number of unschooled children. In study 1 we managed to include only 6 unschooled children and 12 in study 2. Due to the lack of unschooled subjects we limited the number of participants from the group of occasionally and regularly schooled children as well.

Another limitation of the study was the inadequate testing conditions encountered in the group of unschooled children mentioned above.

References

Berry, J. W., Poortinga, Y. H., Segall, M. H., Dasen, P. R. (2002). *Cross-cultural psychology: Research and application.* Cambridge University Press.

Brouwers, S. A., Mishra, R. C., Van De Vijver, F. J. R. (2006). Schooling and everyday cognitive development among Kharwar children in India: A natural experiment. *International Journal of Behavioral Development,* 30, 559-567.

Cahan, D., Cohen, S. (1989). Age versus schooling effects on intelligence development. *Child Development,* 60: 1239-1249.

Case, R., Demetriou, A., Platsidou, M., Kazi, S. (2001). Integrating concepts and tests of intelligence from the differential and developmental traditions. *Intelligence,* 29, 307-336.

Castillo, L.C. (1998). The effect of analogy instruction on young children's metaphor comprehension. *Roeper Review*, 21, 27-31.

Ceci, S. J. (1990). *On intelligence . . . More or less: A bio-ecological treatise on intellectual development.* Englewood Cliffis, NJ: Prentice-Hall.

Ceci, S. J. (1991). How much schooling influence general intelligence and its cognitive components? A reassessment of evidence. *Developmental Psychology, 27,* 703-722.

Christian, K., Bachman, H. J., Morrison, F. J. (2001). Schooling and cognitive development. In R.J. Sternberg, E. L. Grigorenko (Eds.). *Environmental effects on cognitive abilities.* Hillsdale, NJ: Lawrence Erlbaum.

Cliffordson, C., Gustafsson, J. E. (2008). Effects of age and schooling on intellectual performance: estimates obtained from analysis of continuous variation in age and length of schooling. *Intelligence,* 36, 143-152.

Cole, M., Bruner, J. (1971). Cultural differences and inferences about psychological processes. *American Psychologist,* 6, 867-876.

Crone, D., Whitehurst, G. J. (1999). Age and schooling effects on emergent literacy and early reading skills. *Journal of Educational Psychology*, 4, 604-614.

Feuerstein, R. (1979). *The Dynamic Assessment of Retarted Performers.* Baltimore, M. D. University Park Press.

Feuerstein, R. (1980*). Instrumental Enrichment.* Baltimore, M. D. University Park Press.

Feuerstein, R., Feuerstein, R. S. and Falik, L. H. (2008). *LPAD. Learning Propensity Assessment Device.* International Center for the Enhancement of Learning Potential, Jerusalem, Israel.

Fuller, B., Clarke, P. (1994). Raising school effects while ignoring culture? Local conditions and the influence of classroom tools, rules, and pedagogy. *Review of Educational Research,* 64, 119-157.

Hansen, K. T., Heckman, J. J., Mullen K., J. (2003). The effect of schooling and ability on achievement test scores. *IZA Discussion Paper No. 826.*

Helms-Lorenz, M., Van De Vijver, F. J. R., Poortinga, Y. P. (2003). Cross-cultural differences in cognitive performance and Spearman's hypothesis: *g or c? Intelligence, 31, 9-29.*

Herrnstein, R. J., Murray, C. (1994). *The Bell Curve.* New York: Free Press.

Irvine, S. H. (1979). The place of factor analysis in cross-cultural methodology and its contribution to cognitive theory. In L. Eckensberger, W. Lonner, Y. H. Poortinga (Eds.). *Cross-cultural contributions to psychology,* Lisse The Netherlands: Swets & Zeitlinger, sbet00-343.

Lave, J. (1997). What's special about experiments as context for thinking? In M. Cole, Y. Engeström, O. A. Vasquez (Eds.). *Mind, culture, and activity: Seminal papers from the Laboratory of Comparative Human Cognition,* (pp.57-69). Cambridge University Press.

Piaget, J. (1965). *Psihologia inteligenței.* Ed. Științifică, București.

Piaget, J. (2001). *The psychology of intelligence*, London: Routledge. (first published in 1947).

Posner, J. K. (1982). The development of mathematical knowledge in two west African societies. *Child Development,* 53, 200-208.

Stelzl, I., Merz, F., Ehlers, T., Remer, H. (1995). The effect of schooling on the development of fluid and crystallized intelligence. A quasi-experimental study. *Intelligence,* 21, 279-296.

Tulviste, P. (1991). *The cultural-historical development of verbal thinking.* Commack, NY: Nova Science.

Tzuriel, D., and Klein, P. S. (1985). Analogical thinking modifiability in disadvantaged, regular, special education, and mentally retarded children. *Journal of Abnormal Child Psychology* 13: 539–552.

Tzuriel, D., Klein, P. S. (1987). Assessing the young child: Children's analogical thinking modifiability in: Lidz, C.S. (Ed). *Dynamic assessment,* New York: Guilford Press, p. 268-282.

Van de Vijver, F. J. R., Willemse, G. R. (1991). Methods and data analysis of comparative research. In J. W. Berry, Y. H. Poortinga, J. Pandey (Eds.). *Handbook of cross-cultural psychology.* Boston: Allyn & Bacon, 257-300.

Van de Vijver, F. J. R. (2002). Inductive reasoning in Zambia, Turkey and the Netherlands: Establishing cross-cultural equivalence, *Intelligence,* 30, 313-351.

Van de Vijver, F. J. R., Brouwers, S. A. (2009). Schooling and basic aspects of intelligence: A natural quasi-experiment in Malawi. *Journal of Applied Developmental Psychology,* 30, 67-74.

Vygotsky, L.S. (1971, 1972). *Opere psihologice alese. Vol I și Vol II*, E.D.P. București

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Winship, C., Korenman, S. (1997). Does staying in school make you smarter? In B. Devlin, S. E. Fienberg, D. P. Resnick, K. Roeder (Eds.). *Intelligence, Genes and Success: Scientists Respond to the Bell Curve.* Springer-Verlag. 215-234.

Never Say Never to Learning – Dynamic Cognitive Intervention (DCI) for persons with Severe Mental Illness

NOAMI HADAS-LIDOR [1]
PENINA WEISS [2]

Abstract

The purpose of this paper is to describe evidence-based research carried out in populations related to the field of mental health, based on the theories and work done by Prof. Reuven Feuerstein. These studies originated from Hadas-Lidor's Dynamic Cognitive Intervention (DCI) approach, which is derived from Feuerstein's Structural Cognitive Modifiability theory. DCI is specifically intended for enhancement of therapeutic-based relationships with a direct emphasis on emotional-related issues and the way they affect cognitive development.

One of the populations in which functional-cognitive abilities may be compromised is the population of people coping with mental disorders, due to effects of the illness and/or medication side effects.

The outlook for people diagnosed with mental illness has improved in the past several decades due to reasons related to brain research development, third generation medications and various psychosocial and cognitive treatments. These have allowed those coping with mental illness to achieve meaningful recovery, manage residual symptoms, and lead productive lives. Yet additional efforts are needed to consolidate these improvements and help more people with mental illness to reach these goals.

Due to the negative effects of mental illness, positive communication skills and abilities may be compromised, whether for those coping with mental illness themselves, or for those providing care for them either professionally or as family members. In order to enhance learning and cognition, improve communication and instill hope and meaning for all involved, the DCI approach provides a basis for various interventions related to mental health that promote resilience, participation and recovery.

DCI incorporates use of Mediated Learning Experiences, exercises from Feuerstein's Instrumental Enrichment program, and additional tools developed, such as reading and writing tasks, utilization of personal picture albums and Meaningful Interactional Life Episodes (MILEs). The studies reviewed in this

1. School of Occupational Health, Tel Aviv University. Address of correspondence: noami.h@gmail.com;
2. Tel Aviv University

article include evidence for the benefits of DCI based interventions structured for those coping with mental illness, family, and professional caregivers.

Keywords

Feuerstein, Mental Health, Recovery, Caregivers, cognitive intervention

Introduction

Over the past fifty years the field of mental health care has greatly developed. In the past, mental illness was often associated with neuro-cognitive degeneration and chronic deterioration of cognitive functions and abilities, with no hope for rehabilitation and recovery. This usually was translated into a focus on disability and weaknesses, social exclusion, lessened participation and a lack of independence. For many years those suffering from mental illness did not receive cognitive therapy, due to the belief that the cognitive impairment was irreversible, together with the fact that cognitive intervention foundations were based on neuropsychology and therefore applied primarily for people coping with brain injury (Green *et al.*, 2000).

In recent years there are growing interactions between the fields of mental health and neuroscience research. Current trends in research on brain plasticity, together with the exponential growth in new technology, show the brain to be a far more plastic organ than previously thought (Doidge, 2007; Kleim & Jones, 2008). After injury, the brain is capable of considerable reorganization that forms the basis for functional recovery (Sohlberg & Mateer, 2001). The fact that specific alterations in behaviour are reflected in characteristic functional changes in the brain is currently accepted by biologists (Kandel, 1998, 2006). Thus, the ideas related to cognitive modifiability expressed by Feuerstein (Feuerstein *et al.,* 1979; Feuerstein *et al.,* 1980), pertaining to structural cognitive changes, are being found to be not just theoretical but are becoming scientifically validated (Hadas-Lidor *et al.,* 2011).

Thanks to the developments in the field of brain research as it relates to mental illness, together with advances in psycho-pharmacology, new attitudes and approaches that promote recovery, community integration and rehabilitation are developing. These include psycho-education and psychosocial approaches and programs, cognitive interventions, psychiatric rehabil-

itation approaches and settings. These have brought about a huge change in the quality of life of many people coping with severe mental health illness (Lachman &Hadas-Lidor, 2003).

Concurrent with the changes in the mental health field, in the 80s' the consumers of mental health services started the Recovery movement. The recovery movement has turned into the central approach to interventions in mental health, primarily within the community (Friedli, 2010). In Recovery, illness is viewed as a process and journey toward a satisfying and meaningful life despite the illness, instead of regarding recovery as a 'cure' (Anthony, 1993; Deegan, 1996; Liberman & Kopelowitz, 2005). Recovery places an emphasis on therapeutic relationships, demanding that providers collaborate closely with each consumer to discover their unique path to healing (Tew *et al.,* 2011). Recovery is defined as a deeply, personal, unique process of changing one's attitudes, values, feelings, goals, skills and roles. It is a way of living a satisfying, hopeful and contributing life even with limitations caused by the illness. Recovery involves the development of new meaning and purpose in one's life, as one goes beyond the catastrophic effects of mental illness (Anthony, 1993).

Feuerstein and the Recovery movement share common beliefs and concepts, such as the belief in a persons' ability to change, focusing on strengths and not weaknesses, hope, the importance of experiencing competency. Hadas-Lidor, in the development of DCI combines these entities, both in theory and practice.

There is a growing body of knowledge that provides evidence that cognition is a good predictor of functional rehabilitation outcomes in schizophrenia (Green *et al.,* 2000). Cognitive interventions, whether in group or individual format, have become one of the central methods of intervention in this population (Silverstein *et al.,* 2001). The literature provides evidence to the fact that cognitive interventions are beneficial for the population of the people with severe mental illness (Bellack et al., 2004; Hadas-Lidor et al., 2001; Kandel, 1998; Kern et al., 2001; Silverstein et al., 2001; Spaulding, 1994).

One of the developments in the field of cognitive interventions in mental health is based on the theories developed by Feuerstein (Feuerstein, Rand, Hoffman, & Miller 1980; 2006).

Feuerstein (1980) formulated his theory of Structural Cognitive Modifiability (SCM), which presented the human being as an open system that can be modified regardless of age and disability status. In general, Feuerstein's

approach is concerned first with the cognitive prerequisites of human learning and problem-solving abilities; second, with examining why these abilities fail to develop during early childhood in the absence of human mediation; third, with focusing on systematic learning mediated by a caring adult; and fourth, with how much later than generally thought possible, identified cognitive deficits can be remediated by a formal instructional program. This formal program is based on a deductive style of training and teaching. Hadas-Lidor and her colleagues contributions' to the field of dynamic cognition is in her approach being therapeutically based while including Recovery and rehabilitative approaches, together with putting a direct emphasis on emotional-related issues and the way they affect cognitive development and function. Her developing theory, over the past 20 years, Dynamic Cognitive Intervention (DCI) evolved from her being an occupational therapist in the field of mental health. Activity, participation and task analysis make up the core of the Occupational therapy profession. Cognition is one of the abilities both targeted as an outcome as well as a pathway to achieve participation in everyday life activities and community integration. Following her exposure to Feuerstein's theories she applied this knowledge to structuring the Dynamic Cognitive Intervention (Hadas-Lidor, Kozulin, & Weiss, 2011), primarily for use in mental health but gradually expanding and applied with a broad range of clients coping with various disabilities such as, learning disorders, ADHD, acquired and traumatic brain injuries, dementia and old age, etc.

DCI emphasizes the human emotional experience in combination with communication, cognition and activity in various life situations. Its purpose is to enrich the learner and expand his range of coping and behavioural strategies. This expansion happens with the use of Feuerstein mediation principles that underwent renewed interpretation, to include and highlight the addressing of emotional aspects within everyday life interactions .For example, Mediation of meaning is interpreted not just as in the meaning and understanding of things socially and culturally, rather, what is personally experienced as being meaningful, accentuating on what has meaning for me, providing an emotional substance experienced by both learner and mediator. Mediation of Competence, is not just focusing on a feeling of ability, rather, it also includes strategies to build up feelings of ability, such as, provision of feedback, focusing on learning from successes, active listening and more. Transference is not just linking a specific activity with others to promote the acquisition of principles or concepts. It is a tool used to actively en-

hance and bring into awareness meta- cognition by teaching the cognitive principles and mediation components themselves in order to promote both occupational and social skills.

In addition to Instrumental Enrichment, various intervention techniques are activated, such as using family picture albums, reading and writing assignments, one of which is the Meaningful Interactional Life Episode (MILE). MILEs are used in order to enhance learning and encourage the transfer of knowledge and communication skills acquired during DCI individual or group interventions, to participants' natural environment. MILEs are real-life documented verbal interactions experienced and submitted by those receiving DCI. The DCI expert analyses these MILEs and provides feedback to DCI recipient regarding central components crucial to the development of learning and/or improved communications that are present or lacking within the MILE (Weiss, 2013).

DCI principles

1. The intervention is structured in accordance with the consumers' choices and needs and not in relation to the diagnosis or the aetiology of the illness.
2. Throughout the intervention there is a continuous process of discourse between mediator and person receiving DCI regarding goals, purpose, progression rate and the intervention methodology.
3. The DCI involves relating to various life aspects and roles- as long as the Mediator uses Mediation within the verbal interaction taking place throughout the intervention.
4. Meta-cognition is used, as DCI principles and intervention strategies are shared and explained to person receiving the intervention, following the belief, which professional tools of trade have to be shared as much as possible with the person receiving the intervention (Knowledge Translation).
5. The entire intervention process is based on mediation, therefore, mediation is taught as a unique and separate methodology, to be applied in every interaction. This entails specialized courses for the teaching of Mediation.

6. All those involved with the person receiving the intervention are familiarized with Mediation strategies.
7. There is no definitive line drawn between assessment, intervention and follow-up. They are intertwined throughout the entire process.
8. Highlighting, cognitive enquiry and analysis of experiences of success, rather than focusing on difficulties and failures. This enables learning from success and turns success into a model for replication.
9. Clearly defining between emotions, cognition and actions is used to help understand the central role cognition plays within interactions, as well as to enable improved cognitive self-control and improved understanding of others participating in interaction.
10. Coexistence of Competence and Dysfunction- Focus on incorporation of different characteristics that permanently reside side by side in each and every one of us, in particular important for persons coping with mental health illness.

DCI additionally expands Feuerstein's approach in relevance to the environmental component. For years, Feuerstein related to the environment as being dynamic and opposed segregation of persons with special needs. DCI goes beyond this by focusing on the human component in the environment- parents, family, caregivers and professionals involved in caring for those with special needs , under the assumption that it is not enough to improve the persons self-ability to learn, but together with a change in the belief system of the carer, in his/her ability to have faith in the person under care on a basis of equality together with acquiring the ability to improve communications by use of mediation techniques based on Mediated Learning Experience parameters- towards promoting Recovery-change, rehabilitation and integration. There is a growing body of studies based on DCI principles. Those that focus on populations of persons coping with mental illness; studies that focus on family caregivers: and studies that focus on professionals. A number of these studies are described below.

Research based on DCI in the mental health illness consumer population

Hadas-Lidor, Katz, Tyano, and Weizman (2001) conducted the first study based on SCM together with the above mentioned DCI principles in which they investigated the effectiveness of cognitive dynamic treatment through the use of IE with adults with mental illness. The participants included 60 consumers who had been diagnosed with schizophrenia and required treatment at a rehabilitation day centre. The consumers were randomly assigned into two groups; one was given IE as the intervention, and the control group received traditional intervention, which included participation in newspaper groups, arts and crafts. In the study group only certain exercises were used, specifically those that relate to rehabilitation and recovery, such as, employment integration, making choices, social skill development, etc. The length and scheduling of the intervention were equal for both groups. The study had a pre–post quasi-experimental design and lasted for 6 months. The following variables were measured before and after intervention: cognitive performance, self-concept, and daily functioning. The results after intervention showed significant differences between the study group and the control group in the areas of cognitive performance and daily functioning, in both home and work environments. No significant differences were found regarding self-concept. The findings' of this study, which was the first to examine the effectiveness of IE on adults with schizophrenia, had important implications. It suggests not only that the IE program is effective but also that consumers with schizophrenia can improve their cognitive skills and everyday functioning.

A follow-up study to this study was performed by Speier-Keisar, Hadas-Lidor, &Lachman (2007).Individuals with psychiatric disorders are often excluded and discriminated against in society (Ralph, 2000). This study examined the efficacy of Dynamic-Cognitive Intervention and its influence on cognitive and social functioning of people coping with schizophrenia who reside in the community.

The study was conducted in a community rehabilitation centre. The sample included 28 subjects with schizophrenia, whose age ranged from 23-37 year, who were divided into two matched groups. All of the participants were assessed before and after the intervention. The experimental group received 18 weekly dynamic-cognitive interventions of one hour. The control group

participated in the centre's regular activities which included provision of support, psychotherapy, illness treatment management, and workshops or employment units. A significant improvement was noted for the study group subjects on social F (3, 24) = 18.52, P< .001; cognitive F (3, 24) = 8.17, p<.001 and occupational measures (significant improvement progression of occupational status in study group as compared to controls) as compared to the control group subjects after six months. The results of this study support short-term dynamic-cognitive intervention for individuals with schizophrenia in the community.

In a third study, a comparison of performance of the static version (including an additional exposure) and the dynamic version of the Rey Osterrieth Complex Figure test (ROCF) was carried out. The ROCF is used to assess cognitive functions such as visual-spatial organization, sequencing and memory. Cognitive dynamic assessments of people recovering from mental illness can provide a deeper understanding of learning propensity, and therefore contribute to improving recovery and rehabilitation, whilst developing a feeling of competence and motivation to change. The additional exposure to the figure on the static version of the test was chosen since some of the criticism of dynamic testing methodology, claims that the exposure in itself is the source for improved performance of the copying and memory of the figure during the second part of the dynamic version of the test. The study also examined feelings of competence as experienced by participants' in both groups. The study population was a group of consumers using social club community mental health services (Nachmany-Asher, &Shefa, Hadas-Lidor, 2013). The study included 60 subjects between the ages 23-69. The participants were divided into two groups: in the first group, the static form of the test was administered (including an additional stage of exposure), so it consisted of five stages (1- copying, 2- drawing from memory, 3-exposure to the complex figure without mediation for three minutes, 4- copying and 5- drawing from memory); In the second group, the dynamic form of the test was administered, in accordance with the instructions described in the Learning Propensity Assessment Device (LPAD) manual. In this group, all the subjects received second level mediation that included verbal analysis of the components of the complex figure. In addition, subjects of both groups were asked an open-ended question about their feeling of competence at the end of the test. Amongst subjects who underwent the dynamic form of the test significantly higher results were found in comparison to those who underwent the

static form on second copying, second drawing from memory, the rate of change and the grading of competence at the end of the test. The researchers conclude that the dynamic form of the ROCF provides a more in-depth understanding of learning propensity and subject's competence. Increasing use of the dynamic form could guide occupational therapists and other professionals in constructing a better tailored intervention plan for consumers, increase their feeling of competence, encourage them to continue in their efforts and activities and therefore promote their rehabilitation.

Research based on DCI with the population of family caregivers

Family caregivers have been defined as the most important human resource for home-based long-term care (World Health Organization, 2000). Keshet, is an instructional and educational course given in academic settings for those caring for their family's mentally ill members, since 2001. The Keshet course aims at enhancing positivistic family cognitive communication skills in everyday life interactions. It is based on Feuerstein's theory of Structural Cognitive Modifiability (Feuerstein, Rand, & Feuerstein, 2006) and the Dynamic Cognitive Intervention principles of Hadas-Lidor and Weiss (Hadas-Lidor, Weiss, &Kozulin, 2011). Meaningful Interactional Life Episodes (MILEs) are used in order to enhance learning and encourage the transfer of knowledge and communication skills acquired within the course framework, to participants' natural environment. These are real-life documented verbal interactions experienced and submitted by participants. Keshet moderators analysed these MILEs and provided feedback to participants regarding these MILEs as they relate to course content.

The goal of the course is to train parents and caregivers awareness in the use of cognition; to better understand the behaviour of their mentally ill child and to react to him/ her in a controlled and structured manner, in order to influence his/ her responses via their interactions with him. Furthermore, the participants are encouraged to use mediation in their interactions with medical and rehabilitation services personnel.

In an initial study following the first 3 Keshet groups, a pilot study was carried out with a group of 11 participants. They completed an attitude questionnaire relating to beliefs, self-knowledge and actions in relation to their children, before and after the course. Participants reported a higher level of

knowledge, beliefs and changes in their actions that they interpreted as positive, following the Kismet course (Hadas-Lidor, Hasdai, &Jarus, 2006). These results were replicated in additional groups of Keshet (Weiss, 2013).

An initial study that evaluated Keshet was performed by Shor (2009). Eighty eight Keshet participants participated in this evaluation. The objective of the evaluation was to evaluate the contribution of the course and the changes they experienced during and after the course, as a result of their learning the DCI approach. The methodology was based on multiple single subject designs, and the implementation of quantitative and qualitative methods. The findings indicate that the Keshet program changed the participants' perception of their life incidents with which they are coping and of the resources available to them in coping with these incidents.

A study conducted by Redlich, Hadas-Lidor, Weiss, and Amirav (2009) examined whether the Keshet program effectively increases family members' hope for themselves versus hope for their ill relative. The experimental group was composed of 49 family members who participated in the Keshet program for 6 months, in contrast to the control group, which comprised 22 family members, who underwent no structural intervention. Hope was measured at baseline and after 6 months using the Hope Scale, developed by Snyder (1998). No difference in self-perception was detected in Hope Scale scores between groups; however, the Keshet program significantly increased the hope of families concerning the ill person while decreasing the gap between the hope of family members regarding themselves and the affected person. Thus, the program may increase the families' feeling of hope during the journey toward recovery of family members with mental illness.

Keshet was also the platform for the examination of cultural differences in the ultra-Orthodox Jewish community. (Weiss, Hadas-Lidor, Shor, 2013)The influence of the familial context of people with mental illness has come to be recognized as being significant to the course of mental illness; however, the role of culture in the manifestations of the dynamics within families of persons with mental illness has been an unexplored subject. A study (Weiss, Hadas-Lidor & Shor, 2013) was performed of 24 ultra-orthodox Jewish mothers of persons with mental illness, who live in a relatively closed religious community in Israel. As part of their participation, the members of two groups of the Kismet educational program designated for family caregivers of persons with mental illness were asked to write meaningful interactional life episodes (MILEs), which focused on stressful events in their lives. Qualitative analysis

of 50 MILEs illuminated the significant role that religious and cultural norms had in the perceptions of what the participants considered stressors and the dynamic in the families in regard to these stressors. Four themes were identified: (a) conflicts between religious rituals and the disability; (b) stressors that stem from the need to maintain the secrecy of familial events in a collectivist society; (c) stressors that stem from time-related events, such as holidays; and (d) mothers as a major bearer of the burden of caregiving. The authors emphasized the importance of relating to cultural factors in family educational programs and interventions, because this may contribute to the potential use and success of mental health services within a population that essentially underutilizes these services. Accruing this knowledge is essential if therapists want to adapt the methods of interventions in educational programs, such as Keshet, to the needs of parents living in a closed religious collectivist society. The MILEs could also be applied as a means of developing culturally oriented techniques with other cultural populations and members of racial/ethnic minority groups that underutilize mental health services because of cultural barriers. In the work of Feuerstein, there is an emphasis on the adaptations needed for minority populations, such as immigrants from countries such as Ethiopia and North Africa, stating that we should not regard them as people who lack intelligence, rather as people who are culturally different (Feuerstein, &Richel, 1963).

A comprehensive effectiveness study of Keshet was conducted by Weiss (2014).

Study objectives were (a) to develop an instrument for structured analysis of the MILEs (b) to examine the effectiveness of the Keshet course for family caregiver wellbeing and (c) to develop a "Knowledge Translation" based model of cognitive educational intervention for family members of persons coping with mental disorders based on an occupational therapy domain perspective relating to communication and recovery.

Methodology: The first section of this study includes the development of a tool for the analysis of MILES, the Meaningful Interactional Life Episodes Evaluation Tool (MILEET). Keshet moderators were the designated population for the tool development study. Their written responses to MILEs were compared and analysed pre/post use of this newly developed tool.

As Keshet is a complex health intervention, the intervention effectiveness section of this study utilized a mixed methodology approach. Quantitative questionnaires relating to family attitudes, problem solving, communication

skills, goal attainment, burden and quality of life, were used for this study. The design is quasi-experimental, using the same group of people at different stages. Thirty-eight participants filled out study evaluation questionnaires at three different times: at least three months prior to course attendance, at initiation and at completion of the course. This created a control condition (waiting list) and a study condition (pre-post course attendance). Finally, focus groups of graduating Keshet participants were held in order to provide a qualitative perspective.

Findings

The MILEET development resulted in the structuring of a reliable tool for MILE analysis, yet the use of the MILEET did not evoke a significant improvement in MILE analysis for experienced Keshet moderators. Regarding the effectiveness outcome study, following Keshet participation, and as compared with the study control condition, quantitative findings pointed to significant changes in participants' attitudes regarding knowledge of how to cope with a mentally ill family member. Participants also reported a significant improvement with regard to objective and subjective burden. Participants and moderators identified a significant positive change in the ability of participants to cope with the MILEs. Qualitative data analysis revealed three central themes (1) Keshet is an attempt to go beyond the despair and frustration to improved relationships with self, child and the health system; (2) Keshet is a means to improve communication empowerment and feelings of competency and (3)The group leader's meaningful role and effect on learning and promoting recovery and change.

Conclusions

Keshet aids family caregivers in mental health in the development of skills and attitudes that improve cognitive communication skills and in turn, improves resilience in the caregiving role. This is accomplished with the use of the MILEs that provide meaningful links between theoretical components taught and the participant's actual experiences. Caregiver resilience is identified as being a meaningful outcome which to date has not received sufficient attention. The MILEET, developed within the framework of this study, is a re-

liable tool, apparently primarily useful for novice moderators. For the population of family caregivers in mental health, Keshet is an intervention model that promotes Knowledge Translation that may positively affect public health and promotion.

Policy implications and recommendations

Inclusion of Keshet as an evidence based intervention for family caregivers in mental health within designated family centres operating in Israel under the Rehabilitation of the Mentally Disabled in the Community Law (2000) is recommended. Further research on the use of MILEs as a tool for the development of communication patterns based on cognition and mediation and a longitudinal study focused on the resilience of caregivers as it relates to participation in Keshet are warranted.

Research based on DCI with professionals

For the past ten years, specialized programs in the study of DCI intended for professionals are given in academic institutes in Israel. In preparation for the development of these studies, a group of therapists participated in a workshop aimed at developing teaching and mediation skills. The training in the workshop itself, was based on application of the dynamic cognitive approach. The study evaluated attitudes held by the participants toward teaching roles before and after the workshop. On the basis of both qualitative and quantitative analyses, it appears that the workshop facilitated changes in participants' attitudes toward teaching, on emotional, cognitive, and practical levels.

The questionnaire is composed of two sections, one quantitative and the other an open ended qualitative question.

The questions on the questionnaire were organized randomly and divided into three groups, three questions per topic: knowledge and emotions related to teaching, and questions relating to feelings of competence regarding teaching.

Eighteen participants filled out attitude questionnaires at initiation and termination of the program.

A *t* test analysis of the participants' responses to the questionnaire revealed significant differences in attitudes regarding knowledge, emotions, and teaching competence. The combined score for all three sub scales showed an average score at termination as being significantly higher than at initiation. These findings point to significant changes in beliefs, emotions, and behaviours in relation to participants' roles as dynamic cognitive therapists and to their belief in their clients' ability to change and develop as a result of the therapeutic intervention and interaction. In the qualitative section of the study, participants identified strengths and weaknesses in their teaching skills, and conveyed how the workshop had improved their skills as teachers and instructors (Hadas-Lidor, Naveh, & Weiss, 2006)

An additional study assessed the actual effects of the academic study programs in DCI for professionals. Program participants come from diverse health-related professions and the program enabled the development of common grounds for communication and intervention principles which were enhanced while maintaining unique professional identity is maintained. Efficacy of the program was assessed by giving attitude questionnaires to participants before and after conclusion of the program. These point to significant changes in beliefs, emotions, and behaviours in relation to participants' roles as dynamic cognitive therapists and to their belief in their clients' ability to change and develop as a result of the therapeutic intervention and interaction (Hadas-Lidor, & Weiss, 2007).

Conclusions

Prof. Reuven Feuerstein's work and the theories he developed have reached and are being applied far and beyond the populations he started out working with. One of these populations, as described in this paper are those coping with mental health illness. DCI is based on the SCM and MLE theories, together with elements from the recovery vision, an emphasis on emotions and cognition and meta-cognition as implemented in the profession of occupational therapy. We believe that the DCI principles which integrate these components can advance people on their Recovery journey.

This paper reviewed studies based on DCI in populations related to the field of mental health. Three studies were conducted within the population of persons coping with mental health illness, five studies involved families of

persons coping with mental illness and two studies were carried out with professionals who provide mental health services.

These studies point to the effectiveness of Dynamic Cognitive Intervention, its' importance for consumers, caregivers and professionals in the field of mental health, and the broad spectrum with whom this intervention may be applied. DCI does not focus on illness and illness management. It is rather based on a universal outlook on cognitive modifiability and the use of mediation for **positive** communication applications. Regarding the Keshet intervention for family caregiver's that is based on DCI, it is clear that the mental health family caregiver's needs should be addressed since home-based care is an integral component of all health and social systems. Keshet is held within settings that are identified within a health and not an illness perspective (academic setting vs. hospital/clinic). Within this context it is important to initiate such interventions and encourage family caregivers to participate in these interventions from the early stages of their coping with family mental illness. The population of caregivers should be encouraged and reinforced in their need for support, caring for themselves, and acquiring practical strategies for improved caring and coping. Public health care providers and program instigators should be made aware of the importance of these crucial needs.

Additional studies on the use of DCI as a basis for identifying communication patterns and the establishing of effective cognitive communication in various populations of persons with special needs are warranted.

When Prof' Reuven Feuerstein was asked whether cognitive interventions would make people happier, he answered "*Happiness is in Gods' hands. My role is to expand people's possibilities and ability to make choices".*

References

Anthony, W.A. (1993). Recovery from mental health illness: The guiding vision of the mental health service system in the 1990s. *Psychological Rehabilitation Journal*, 16, 11–24.

Bellack, A.S., Mueser, K.T., Gingerich, S., & Agresta, J. (2004).*Social skills Training for Schizophrenia.* NY London: The Guilford Press.

Deegan, P.E. (1996). Recovery as a journey of the heart. *Psychiatric Rehabilitation Journal*, 19(3), 91-97

Doidge, N. (2007). *The brain that changes itself*. Penguin: London.

Feuerstein, R., with Rand, Y., Hoffman, M. B., & Miller, R. (1980). *Instrumental enrichment: An intervention program for cognitive modifiability.* Baltimore: University Park Press.

Feuerstein, R.,withRand, Y., & Hoffman, M. B. (1979) *The dynamic assessment of retarded performers: The Learning Potential Assessment Device, theory, instruments, and techniques.* Baltimore: University Park Press.

Feuerstein, R. &Richel, M. (1963).Children of the Malach: C*ultural depravation of Moroccan children and its meaning for Education.* The Jewish Agency, Henrietta Sold Institute, Jerusalem.

Feurstein, R., Rand, Y., &Feurstein, R.S. (2006).*You love me!!...Don't accept me as I am. Revised and enlarged edition.* Jerusalem: InternationalCenter for Enhancement of Learning Potential Publications.

Green, M.F., Kern, R.S., Braff, D.L. &Mintz, J. (2000). Neurocognitive Deficits and Functional Outcome in Schizophrenia: Are We Measuring the "Right Stuff"? *Schizophrenia Bulletin*, 26, 119–136.

Hadas-Lidor, N., Katz, N., Tiano, S., Weizman, A.(2001) Effectiveness of Dynamic Cognitive Intervention in Rehabilitation of Clients with Schizophrenia. *Clinical Rehabilitation*: 15 (4), August 2001.349-359

Hadas-Lidor, N., & Weiss, P. (2007), An academic diploma program as a lever for personal and professional growth and empowerment. *The Israel Journal Of Occupational Therapy*, 16,3, E61-E74.

Hadas-Lidor, N., Naveh, E. & Weiss, P. (2006). From Therapist to Teacher: Development of Professional Identity and the Issue of Mediation. *Journal of Cognitive Education and Psychology,* 6,1, 100-116.

Hadas Lidor, N., Hasdai, A., Jarus, T., "KESHET" – advancement participation and communication course for parents and caregivers for cognitive communication *Israel Journal of Occupational Therapy*: 15 (1) February 2006, 31-46, (Heb.)

Hadas-Lidor, N., Weiss, P. & Kozulin, A. (2011). Dynamic Cognitive Intervention: Application in Occupational Therapy. In N. Katz (Ed.) *Cognition, Occupation, and Participation Across the Life Span* (pp.323–350). Bethesda, MD: AOTA.

Kleim, J., & Jones, T. (2008). Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage. *Journal of Speech, Language, and Hearing Research*, 51 225-239.

Liberman, R.P., &Kopelowitz, A. (2005). Recovery from Schizophrenia: A concept in search of research. *Psychiatric Services*, 56, 735–742.

Rehabilitation of the Mentally Disabled in the Community Law, 2000 . Jerusalem, Ministry of Justice, 2000. Available at www.old.health.gov.il/Download/pages/lawENG040409_2.pdf

Silverstein SM1, Menditto AA, Stuve P. (2001) Shaping attention span: an operant conditioning procedure to improve neurocognition and functioning in schizophrenia. *Schizophrenia Bulletin*.;27(2):247-57.

World Health Organization. (2000). *Home-based long-term care: Report of a WHO study group.*(Technical report series 898).Geneva: Author. Retrieved May 4, 20011, from http://whqlibdoc.who.int/trs/WHO_TRS_898.pdf

Tew, J., Ramon, S., Slade, M., Bird, V., Melton, J., & Le Boutillier, C. (2011). Social factors and recovery from mental health difficulties: A review of the evidence. *British Journal of Social Work* [June]1–18

Friedli, L. (2010). *Proceedings of the 2010 Refocus on Recovery conference, Institute of Psychiatry, London.* Retrieved from http://www.researchintorecovery.com/conference/materials.html accessed 1-2-11

Kern, R. S., Wallace, C. J., Hellman, S. G.,Womack, L. M & Green, M.F. (1996). A training procedure for remediating WCST deficits in chronic psychotic patients: an adaption of errorless learning principles. *Journal of Psychiatric Research*,30, 283-294

Medalia, A., Revheim, N., &Casey, M. (2001). The remediation of problem solving skills in schizophrenia. *Schizophrenia Bulletin*, 27, 259-267.

Kandel, E. R. (1998). A new intellectual framework for psychiatry. *American Journal of Psychiatry*, 155, 457–469.

Ralph, R.O. (2000). "Recovery". *Psychiatric Rehabilitation skills*, 4(3), 480-517.

Spaulding W.D.(1994) (Eds) *Cognitive technology in psychiatric rehabilitation*. University of Nebraska press.

Shani Shefa, Orit Nahmani Asher, NoamiHadasLidor (2013). Comparison between Static and Dynamic Forms of the Rey Osterrieth Complex Figure Test (ROCF) and Their Impact on the Self-Efficacy of People with Mental Illness in the Community. *The Israeli Journal of Occupation Therapy*, November 2013, 22(4) 85-103

Sohlberg, M. M., & Mateer, C. A. (2001). *Cognitive rehabilitation: An integrative neuropsychological approach*. New York: Guilford Press.

Redlich, D., Hadas-Lidor, N., Weiss, P., &Amirav, I. (2009) Mediated Learning Experience Intervention Increases Hope of Family Members Coping with a Relative with Severe Mental Illness. *Community Mental health Journal*. DOI 10.1007/s10597-009-9234-3,

Shor, R. (2009). *The Keshet program-Advancement, participation and communication*. The Israeli National Insurance Institute, Research and Planning Administration, Division for Service Development, Special report No. 130, Jerusalem.

Speier-Keisar V. , Hadas-Lidor N., Lachman, M. (2007) The Efficacy of Dynamic-Cognitive and Social Functioning of Persons with Schizophrenia in the community, *The Israeli Journal of Occupation Therapy*, vol 16 (1) p (3-27),

Weiss,P., Hadas-Lidor, N., &Shor, R.(2013). Cultural aspects within caregiver interactions of ultraorthodox Jewish women and their family members with mental illness. *American Journal of Orthopsychiatry*, 83' 520-527

Weiss P. (2013). *Keshet-A Cognitive Educational Intervention Model for Family Caregivers of Persons Coping with Mental Disorders: Providing Evidence for Effectiveness.* University of Haifa, Unpublished manuscript.

Adults with intellectual disability are accessible to change beyond the limitation of age - from vision to empirical findings

HEFZIBA LIFSHITZ –VAHAV [1]

Abstract

The Structural Cognitive Modifiability theory and the active modifying approach were developed by Reuven Feuerstein and his colleagues in the mid-1970s (Feuerstein and Rand, 1974). The basic assumption underlying these theories is that, by nature, the human organism is a system open to its environment and accessible to change, even in the presence of three formidable obstacles usually believed to prevent change, to wit, (a) age, (b) aetiology, (c) severity of limitation. The goal of this article is to show the evolution of Feuerstein's theory from vision to empirical findings in a population of adults with intellectual disability (ID). The article will present his thesis, the empirical findings which support it, the theoretical outcomes and the educational implementations of his theories in the field.

Keywords

adults with intellectual disability, cognitive modifiability, compensation age theory, cognitive educational programs

The Structural cognitive modifiability (SCM) and the Active modifying approach were developed by Reuven Feuerstein and his colleagues in the mid-1970s (Feuerstein and Rand, 1974; Feuerstein, Rand, Hoffman and Miller, 1980). The basic assumption underlying these theories is that, by nature, the human organism is a system open to its environment and accessible to change, even in the presence of three formidable obstacles usually believed to prevent change, to wit, (a) age, (b) aetiology, (c) severity of limitation (Feuerstein, Rand & Hoffman, 1979; Feuerstein & Rand, 1974; Feuerstein, Rand, Hoffman & Miller, 1980; Feuerstein, Rand & Rynders, 1988).

1. Associate Professor , Head of ID Majoring Program, Department of Special Education , School of Education, Bar-Ilan University, Ramat-Gan, Israel. Email: Hefziba.lifshitz@biu.ac.il

In the 1970s, the prevailing attitude toward the possibility of change reflected the passive acceptance approach. The concept of cognitive modifiability in a population with intellectual disability (ID) of varied aetiology, including even the lower levels, and especially in adulthood and old age, was regarded as visionary.

It took 20 years for these claims to receive scientific recognition. Currently, Feuerstein's notions are supported not only by behavioural studies, but even by neurological and brain science (Lebeer, 2014). The goal of this article is to show the evolution of Feuerstein's theory from vision to empirical findings in a population of ID. The uniqueness of his theories lies in their not having remained in the academic ivory tower, but rather, have been implemented in the field. We will show the outcomes of Feuerstein's theories among adults with ID at advanced ages, even at lower levels of ID. The Structural Cognitive Modifiability (SCM) and the Mediated Learning Experience (MLE) theory served as the inspiration and scientific basis of the Compensation Age Theory that we developed two years ago (Lifshitz – Vahav, 2011). They also serve as a scientific and humanistic basis for four intervention programs designed for diverse populations with ID throughout the life cycle: children, adolescents, adults and even adults with ID and Alzheimer's disease.

Cognitive and intelligence trajectories in a population of ID

For more than 30 years, scientists have been preoccupied with several intriguing questions regarding cognitive change with increasing age. Does intelligence or cognitive functioning decline with increasing age among adults with Down syndrome, and if so when? Is the trajectory of cognitive decline accelerated or parallel to that of the general population? Can the cognitive functioning of adults with ID with and without Down syndrome be modified at an advanced age?

Fisher & Zeaman (1970) proposed three possible models of intelligence or cognitive trajectories in individuals with ID compared to the general population: the *Impaired Trajectory,* the *Parallel Trajectory* and the *Compensation Trajectory*. These models are based on traditional theories of intelligence in the general population (Wechsler, 1955; Kauffman, 2001), according to which general intellectual functioning increases linearly up to the age of 20 (without

a distinction between crystallized and fluid measures). This development is followed by asymptote (stability), and a decline from around the age of 60. The three models of cognitive trajectories among individuals with ID differ in three dimensions: (a) the age at which intelligence reaches its peak; (b) the length of the stability or asymptote period; (c) the age of the onset of decline. The three possible trajectories of intelligence and cognitive growth and decline in individuals with ID are presented in Figure1.

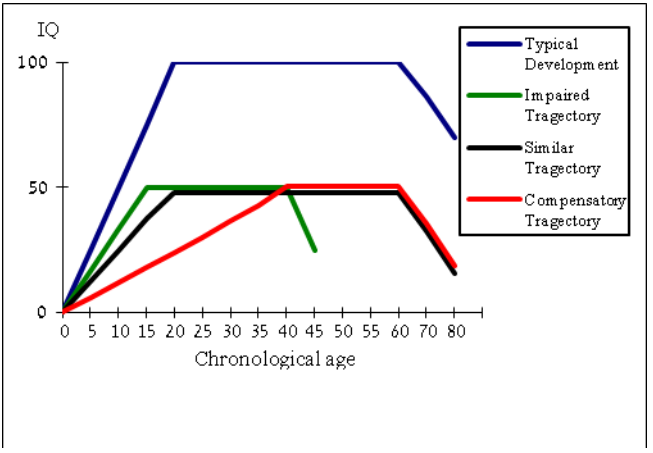


Figure 1. Intelligence and cognitive growth and decline in individuals with ID: Three possible trajectories in individuals with ID compared to the general population.

Until the 1980s, there was a myth of accelerated cognitive decline among adults with ID (White, 1969) that was expressed in the *Accelerated Trajectory*. This model predicted that individuals with ID would exhibit restrictions in developing intelligence before their 20s. Intelligence would reach its peak between the ages 10-15. Thereafter, they would exhibit asymptote, with a very early age onset of accelerated decline in their mid-thirties or forties. From a theoretical point of view, the accelerated trajectory is anchored in the model of the Cognitive Reserve (CR) Theory (Katzman, 1993), which posits that normally occurring individual differences in the way people process tasks might provide a differential reserve against brain pathology or age-related changes. A sub-concept of the CR theory is that of “neural reserve”, which represents the capacity to perform tasks or cope with increasing task difficul-

ty. Individual differences may result from innate characteristics (e.g., intelligence), or may be modulated by life events such as educational or occupational experiences or leisure activities (Scarmeas & Stern, 2003; Wilson & Bennett, 2005). In light of the above, it would not be surprising if the intelligence in a population with ID would peak earlier and exhibit accelerated cognitive decline. Individuals with ID possess less CR than their peers without ID, by definition (Zigman et al., 2004). They have lower intelligence and slower task processing. They do not achieve higher educational levels or occupational statuses, and tend to participate in fewer intellectually stimulating leisure activities.

As time passed, the accelerated trajectory yielded to the *Parallel Trajectory*. This model predicts that intelligence and cognitive development in individuals with ID is similar to that of the general population: it peaks in the twenties, after which there is an asymptote and an onset of decline around age 60. Recent studies have questioned the applicability of the CR theory to individuals with ID (Oliver, Crayton, Holland, Hall, and Bradbury 1998). If by definition, people with ID have reduced CR compared with their peers with TD, then these persons would be expected to be at greater risk for dementia of the Alzheimer type (DAT) with increasing age than the general population (Snowdon, Greiner & Markesbery, 2000). However, several studies (Merrick, 2012; Zigman et al., 2004) found an equivalent or even lower risk of dementia among adults with ID with nonspecific aetiology (NSID). Based on the lower age of onset of DAT among individuals with ID, the above authors reached the conclusion that factors that determine intelligence may have little or no direct relationship to risk for dementia in individuals with NSID. Facon (2008) supported this parallelism by showing that adults with and without ID, aged 20 to 54 years, demonstrate a similar evolution of crystallized and fluid intelligence with increasing age. Devenny, et al. (1992) reported similar trends in short and long-term verbal memory and visual-spatial organization among adults with ID with and without DS, aged 50+, compared to the general population.

Our review of the literature indicated that neither of the above models was correct. Recent studies point to cognitive stability at older ages even among adults with Down syndrome. Chicoine and McGuire (1997) reported on an 83-year-old woman with mosaic DS with "no physical deterioration, memory and skill loss, with relatively good health all her life" (p. 477). Krinsky et al. (2008) reported successful aging in a 70-year-old man with DS with-

out decline in episodic memory or daily living skills. Based on such studies, as well as my own research (presented later), it seemed to me that a third cognitive trajectory model - was needed.

The model which we came to call the *Compensation Trajectory* model (CT): distinguishes between the period of cognitive growth and the period of cognitive stability and decline. It predicts that the duration of the growth period among individuals with ID may be longer than that of the general population. Intelligence and cognitive functioning of adults with ID may continue to grow even until their fifties; there will be stability between the ages of 50 to 60 and above, after which they will show a decline. Thus, individuals with ID will exhibit a different pattern of cognitive growth than individuals with TD, but will show a parallel pattern of cognitive stability and decline.

Empirical findings

In the 80s and 90s, we were the first to address aging phenomena in a population with ID in Israel. Lifshitz (2001) examined aging phenomena of people with intellectual disability (ID) aged 40 -70 (CA = 50.61; *SD* = 8.08) living in various types of community residences (hostel, apartment). Lifshitz & Merrick (2003; 2004) compared adults with ID living in community residences, compared to adults with ID living with their families. In these studies we used the " short version of the Greater Rochester Area Health Status Survey (Janicki & Davidson, 1999), which examines whether deterioration occurs over the years in four cognitive dimensions: speech, comprehension, reading and writing (on 1-4 scale). The findings in the three studies indicate deterioration in health and morbidity, but no decline was found in the four cognitive domains. These findings led us to examine not only the static situation, that is, whether an age-related drop in cognitive skills exists, but also the possibility of altering the cognitive ability of adults with ID even at advanced age. Following are examples of these studies.

Lifshitz & Rand (1999) found improvement in a verbal abstraction test as well as in orientation in time and space among young adults with ID (CA 20-35); middle-aged (36-50); and older adults (CA 50-70) with IQ 40-70. Note, that among the older adults was one 70-year-old, followed by a 65- and a 62-year-old. The central means of intervention were four tools from the Instrumental Enrichment Program (Feuerstein, Rand, Hoffman, & Miller, 1980):

comparison, categorization, time and space relations. The effects of the intervention were examined with reference to three types of thinking (Glanz, 1989): logical thinking (Reversal Test and Test of Verbal Abstraction), predictive thinking (Maze Tests) and insightful thinking (Postures Test and Children Test). The battery was administered five times: twice before the intervention, spaced two months apart, twice afterwards, spaced two months apart, and a follow-up three years later.

MANOVA's and contrast between the four time points in the original study yielded significant improvement from Time 2 to 3, and a divergence effect in logical and predictive thinking two months later (Time 4). The MANOVA's in the follow-up evaluation (Time 5) showed a drop in cognitive functioning relative to Time 4, but participants maintained their achievement in relation to Time 3, a finding that indicates a durability effect. In a follow-up study that was conducted three years later among 21 participants, Lifshitz and Tzuriel (2004) found durability effect. This finding supports Feuerstein's claim that a change obtained after mediated learning experience is structural. Figure 2 presents the cognitive achievements of 21 participants in the three types of thinking at the five time points.

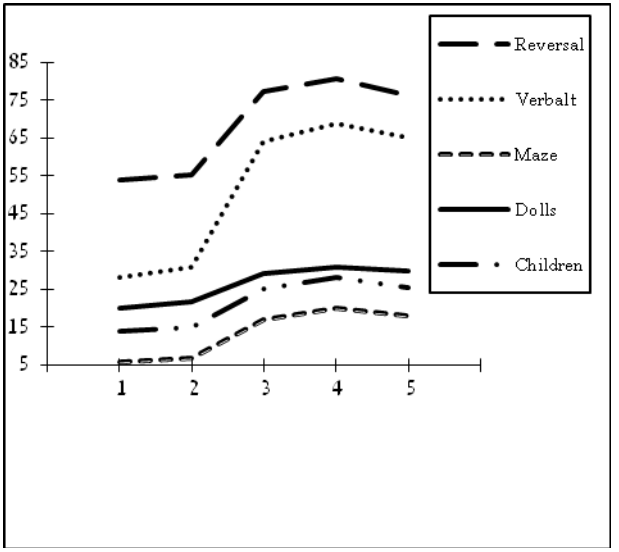


Figure 2. Instrumental enrichment: Results of the five tests in five time periods

Feuerstein and Rand (1974) averred that one of the characteristics of structural change is that the alterations that occur in an individual's behavioural repertoire do not disappear over time; rather, they are significantly evident for a long period. As time passes, functions that were attained improve and become more efficient. This is achieved through the inherent traits of the structure; that is, the tendency toward self-regulation, which leads to self-perpetuating behaviour requiring less investment of energy, which in turn ensures that this behaviour will occupy a relatively high position in an individual's hierarchy of behaviours (Feuerstein, Rand & Rynders, 1988).

Lifshitz, Tzuriel, Tzemach & Weiss (2010) examined the effect of teaching using a dynamic assessment (DA) procedure on solving analogical problems among adolescents (age 13- 21) and adults (age 25-66) with ID (IQ 40-70). The *Conceptual and Perceptual Analogical Modifiability* test (Tzuriel & Galinka, 2000) was used. Repeated measures, MANOVA's and post-hoc tests did not reveal significant differences between the two age groups in the pre-teaching stage. In the post-teaching stage, the adult group scored significantly higher ($p<.05$) than the adolescent group (M=15.09 and M=8.28, respectively). The findings, presented in Figure 3, indicate that the adults gained more from teaching in the DA procedure than the adolescents.

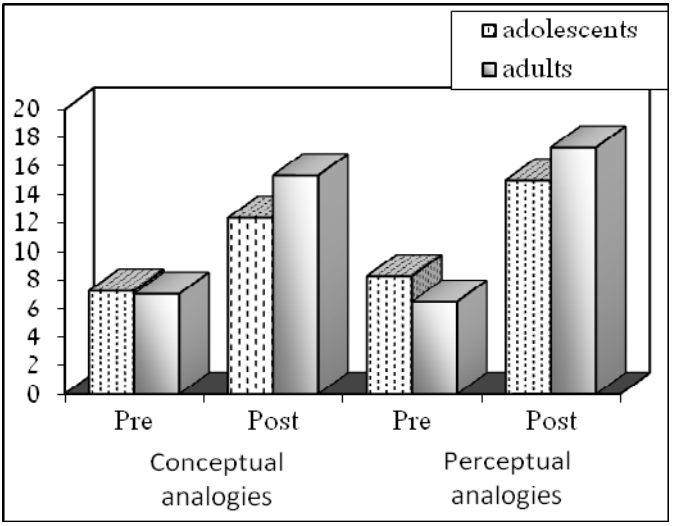


Figure 3. Analogical reasoning: Improvement from pre to post teaching phase: Differences between adolescents and adults with ID

Lifshitz & Katz (2009) examined: (a) the level of understanding of Jewish cognitive concepts among Jewish adolescents and adults with ID (IQ 40-70); (b) the psychological emotional motives of the participants for being religious. The participants included adolescents (age 13-21) and adults (age 30-60) with ID. The cognitive component included four factors: Concept of God, Heavenly recompense - reward and punishment, Divine providence - the sense of the presence of God in everyday life, efficacy of prayer.

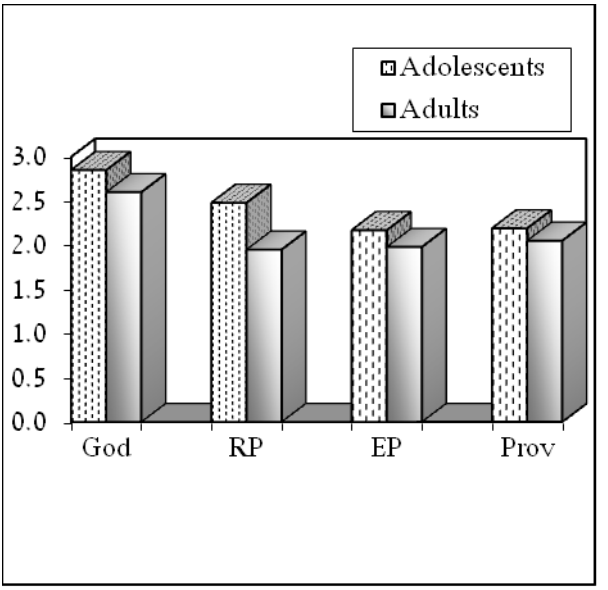


Figure 4. Religious cognitive concept: Differences between adolescents and adults with ID

The scores of prayer efficacy and providence of God were significantly higher among the adults than the adolescents. The adults also exhibited more mature motives for being religious (dependence, security, God as an anchor) than the adolescents (belonging to a religious community, expecting fulfilment of personal wishes). Regression analysis indicated that among the adolescents, MA contributed to the explained variance of the cognitive components, while among the adults, CA contributed to the explained variance of the cognitive component.

An additional study was conducted among adults with severe and profound ID (Lifshitz, Klein, & Fridel, 2010). The goal was to examine the effects of a year-long Mediational Intervention for Sensitizing Caregivers (MISC; Klein, 1992) on the quality of interactions between rehabilitation day centre paraprofessionals and their adult consumers with severe ID. Another goal was to examine the effect of the intervention on the consumers' cognition, autonomy, and behavioural functioning

The objective of the MISC (Lifshitz & Klein, 2007) is to help caregivers and direct staff relate to their dependents in a way that will enhance their cognitive, autonomous, and behavioural functioning. It is not content-specific, but may serve as a tool for teaching "literacy of interaction" in daily activities, such as vocational, domestic, and leisure skills.

Paraprofessional staff members in rehabilitation centres and their consumers with severe and profound ID were divided into an experimental and a control group. The paraprofessionals in the experimental group participated in a workshop on the MISC and then activated the MISC intervention in the rehabilitation centre for one year.

Following the intervention, more mediation of choice making, cognitive expansion, and encouraging with explanation were observed among the paraprofessionals in the experimental group than in the control group. Consumers with ID in the MISC group improved their arithmetic skills, temporal concepts, and sequential memory of two digits (Figure 5). The findings indicate that appropriate environmental conditions and continuous systematic intervention may enable adults with severe and profound ID to invent new skills, which were previously absent from their behavioural repertoire.

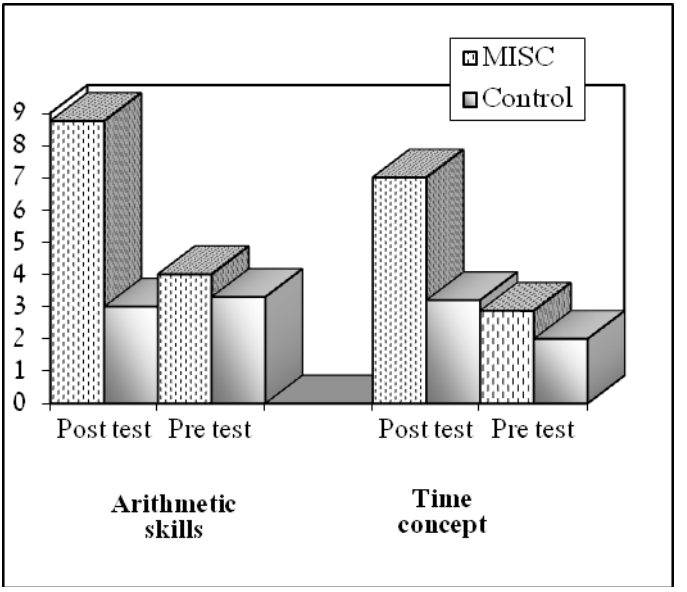


Figure 5. MISC intervention: Differences between the experimental and control groups in arithmetic and time concepts

All these studies indicate that environmental intervention can alter the cognitive ability of adults with ID even at advanced age, and even in severe and profound ID.

The compensation age theory

Based on the empirical findings, WE formulated the *Compensation Age Theory* (CAT). What is the essence of this theory? When considering cognitive education or cognitive intervention programs for individuals with ID, it is assumed that the weight of the mental age (MA) or the basic cognitive level is the crucial factor for determining their cognitive ability. The CAT postulates that the weight of the chronological age (CA) is similar to that of the MA, and that CA plays an important role in determining the cognitive ability of individuals with ID beyond their MA. The CAT is comprised of four statements: (a) Chronological age plays an important role in determining the cognitive ability of individuals with ID, beyond their mental age. Contrary to prior assumptions (Cuppos, 2013), the direction of influence is positive. (b) Intelli-

gence and cognitive performance of individuals with ID might continue to grow till their late 50s; (c) Adults with ID can be modified even at an advanced age; (d) Maturity and cumulative life experience help adults with ID acquire cognitive skills that were previously absent from their behavioural repertoire.

The CAT is conceptually based on complementary theories: those designed for special populations such as Feuerstein's SCM theory, as well as modern gerontological theories such as the Cognitive Reserve Theory, the Cognitive Activity Theory, the Cognitive Rehabilitation Theory and the *lifespan developmental orientation*.

Theoreticians like Bloom (1970) and Piaget (1970) argued that the critical period for intervention to improve cognitive deficiencies occurs at a young age. The SCM theory does not dispute the importance of early intervention, but rejects the idea of critical time for initiating cognitive intervention. This position is supported by recent neurological and brain research. Neuroplasticity is the "ability of the nervous system to respond to intrinsic and extrinsic stimuli by reorganizing its structure, function and connections" (Cramer et al. 2011, p. 1592). The exact mechanism of neuroplasticity related to cognitive aging is still unclear; however, the viewpoint that 'the adult brain is adaptive at any age and has lifelong capacity for change' is on the rise (Mahncke, et al., 2006, p. 12524).

The *lifespan developmental orientation* states that aging is a bipolar period of decline and deterioration on the one hand, but could be a period of growth, development and elevation on the other. The decline in biological potential with age is compensated by the knowledge, wisdom and maturity accumulated by adults throughout the life span. While this approach is accepted for the general population, it has not yet penetrated to populations with ID. The CAT embraces the lifespan orientation and adapts it to populations with ID.

The Cognitive Reserve Theory (CRT) (Stern et al., 2005) is also at the foundation of the CAT, as is its sub-concept, neural compensation. This concept relates to a situation in which the physiological effects of aging or brain pathology cause a brain network to change, resulting in a network that would not normally be used by unaffected individuals, or would be used in a different way, or in recruitment of additional brain areas. Stern et al. hypothesized that the altered network is used to compensate for the inability to utilize the healthy brain's responses to increased task difficulty. The ability of the com-

promised brain to express or optimize compensatory networks may also vary as a function of CR.

One might argue that individuals with ID exhibit lower CR due to their lower level of intelligence, and their having fewer opportunities for cognitive education and cognitive leisure activities. Based on the lower rate of dementia among the population with ID compared to the general population (Zigman et al., 2004), our argument is that CR in individuals with ID should be examined within the population with ID itself, and not compared to the general population. There are individual differences within the population with ID in task processing, according to intelligence level and life events such as occupational and leisure experience. However, as will be shown, individuals with ID can acquire cognitive skills efficiently in adulthood and even at an advanced age. This statement includes all levels of ID: mild/moderate as well as severe/profound.

Recently, the idea of reserve, plasticity and compensation has also been supported by innovative research in genetic and brain science. For example, compensatory, sprouting responses or neural reserve in aging have been observed in rodent and canine models of human brain aging.

Head et al. (2007) found that in rats, voluntary running on a wheel leads to the induction of BDNF in the hippocampus, both at the gene expression level and at protein levels. In another study, a group of aged beagles (9-11 years at the start of the study) was provided with a program of behavioural enrichment that included physical exercise, social enrichment, environmental enrichment and cognitive training. Head et al. observed significant improvements in complex learning ability and maintenance of cognitive function over a treatment period of 2.8 years.

It has been documented that adults with DS develop Alzheimer disease pathology progressively with age (Janicki & Dalton, 2000; Oliver et al., 1998), but clinical signs of dementia are delayed by at least 10 years after the first signs of disease. Furthermore, studies have reported a subset of adults with DS who do not exhibit dementia at any age (Devenny et al., 1992; Zigman, Schupf, Devenny, Miezejeski, Ryan, Urv, Schubert and Silverman, 2004). While virtually all DS subjects older than 40 have a significant neuropathology of dementia, there is a lack of concordance between the typical age of onset for dementia in this aetiology (Mesulam, 1999). Head et al. (2007) suggested that compensatory events may be of particular relevance for the DS group. Their claim is based on fMRI and PET observations of individuals with

DS that indicated compensatory increases in the metabolic rate in vulnerable brain regions in DS prior to the development of dementia. Head et al. (2007) suggested that genes which are over expressed in DS (APP, DSCAM, MNB/DYRK1A, RCAN1) produce proteins critical for neuron and synapse growth, development and maintenance, and provide further evidence for the activation of plasticity mechanisms in this aetiology. These genes may lead to developmental cognitive deficits; but paradoxically, with aging, may participate in molecular cascades supporting neuronal compensation. Based on work in rodent models and in a canine model of human brain aging, Head et al. suggested that the use of behavioural enrichment (including physical exercise) may have a significant impact on healthy brain aging in DS. These same interventions may promote pathways and molecular cascades involving genes over expressed in DS that may enhance compensatory mechanisms.

Implications of the SCM and CAT on cognitive intervention programs for all levels with ID at all ages

We constructed four cognitive educational intervention programs designed for individuals at all levels of ID at all ages, based on the SCM and CAT. We also based the programs on the second theory developed by Feuerstein: the Mediated Learning Experience (MLE). MLE (Feuerstein, 2003; Feuerstein & Falik, 2010) refers to the way in which stimuli experienced in the environment are transformed by a mediating agent, usually a parent, teacher, instructor other intentioned person in the life of the learner. This mediating agent, guided by intention, culture, and emotional investment, selects, enhances, focuses, and otherwise organizes the world of stimuli for the learner, according to a clear intention and goals for that learner's enhanced and effective functioning. According to Feuerstein (2003), what ultimately determines the realization of an individual's potential, even if it is influenced by genetic factors, is the individual's MLE; i.e., the extent to which he/she was exposed to educational, cultural and social stimuli.

The four programs are presented herewith:

(a) Empowerment program: Academic enrichment for adults with mild/moderate ID: This program is designed for adults with moderate and mild ID with/without DS. The program combines humanistic and scientific

goals. It emerges from the UN convention for persons with disabilities: "*Parties shall ensure an inclusive education system at all levels and lifelong learning directed to: The full development of human potential, sense of dignity and self-worth, their talent creativity as well as their mental and physical abilities*" (UN, 2006, p. 20). The Empowerment Program puts these rights into action.

In this program, the students attend the School of Education, Bar-Ilan University (during the academic year) once a week for six academic hours. The courses taught are psychology, sociology, self-advocacy, library and computers and are adapted to the level of the students. The lecturers are students in the Intellectual Disabilities track of the Master's Degree program at the School of Education. Teaching in the project is part of the practicum in the track.

Another group of students with ID are included during the academic year in a BA research seminar on Lifelong Learning of Individuals with Disability, together with regular students. One goal of this special seminar is to teach students with ID to conduct research about themselves. Reciprocal learning takes place between regular students and students with ID. Together they study issues related to self-advocacy. The task of the students with ID is to interview three friends with ID about self-concept, self-efficacy, hope and optimism using questionnaires. The typical students perform the statistical analysis. The two groups analyse the results and draw conclusions together.

The educational objectives of these programs are to acquire knowledge on academic subjects that might be relevant to this population, develop strategies for learning, access the university's libraries, conduct small research projects and use the computer lab. The social objectives are to expose students with ID to students with TD in class and during breaks, expand the friendship circle of students with ID, empower and strengthen their self-image, confidence, and quality of life, and construct positive attitudes towards individuals with disability among the regular students.

The next three programs were designed for individuals with severe and profound levels of ID throughout the life cycle: childhood and adolescents, adulthood and old age. For this purpose, we (Lifshitz & Klein, 2007; 2011; Lifshitz, Klein and Cohen, 2010) adopted three mediational parameters which Feuerstein (Feuerstein et al., 1980; Feuerstein, 2003) indicated as crucial for the success of the mediation process: Transcendence, Mediation of Meaning, and regulation of behaviour to the special needs of individuals with severe and profound ID.

Mediation of meaning: We changed this to providing opportunities autonomy for making choices. Autonomy and choice fulfil a basic human right and enhances the quality of life (Schalock, 1996).

Transcendence (cognitive expansion): We divided transcendence or cognitive expansion according to ID level: (a) Basic cognitive concepts: colour, size and quantity, spatial and temporal orientation (b). Higher levels relating to critical interpretation, clarifying processes, i.e. the meaning of the work, the targeted consumers, and the manufacturing process.

Regulation of behaviour: Our observation of interactions between individuals with ID and their staff led us to base the observation of regulation of behaviour on Gold's (1978) and Luftig's (1987) four stages of task analysis: verbal instruction, modelling, practice and physical assistance when performing ADL tasks. We also related to instructions and rules and correction of maladaptive behaviour.

The acronyms *A (autonomy) B (adaptive behaviour skills) C (cognition) represent* these parameters.

(b) ABC: Enriching cognition and literacy affect and behaviour skills during daily life activities for school-age students with severe/profound ID (Lifshitz-Vahav, Tal, Nissim, & Nissim, in press): We developed this program upon request by the Special Education Division of the Israeli Ministry of Education; it serves as the new Israeli national curriculum for students with severe/profound ID. The essence of this program (published earlier as the MISC approach, Klein, 1992; Lifshitz & Klein, 2007; Lifshitz, Klein, & Fridel, 2010) is introducing cognition, literacy and autonomy during daily life activities to school-age students with severe and profound ID. Mediation of these components is conveyed by the mediators (teachers, paraprofessionals and direct caregivers) through their interaction with their students with ID, not only in formal lessons, but during meal time, domestic skills, sports class, art, occupational therapy, vocational preparation, etc.

There is a myth among teachers, paraprofessionals and even parents that literacy and cognitive skills are beyond the ability of individuals with severe and profound ID. Our experience with the ABC (the MISC) intervention among adults with severe and profound ID (Lifshitz, Klein & Cohen, 2010) indicates that individuals with severe and profound ID can be modified even at advanced age. Based on the above, we constructed a program for school-age students (age 6-21) with severe and profound ID. Some examples of in-

troducing cognition during daily life activities are presented: along with instruction on how to use a spoon or fork, the mediator can talk with the students about the offered foods, the taste, the colour (this tomato is red), the shape (round). When eating cake, the mediator talks about the ingredients, the nutritional components. Written word signs of the menu items are provided. In art class, teachers talk about the colour, shape, design, texture, verbs and nouns related to the work.

Autonomy is an integral part of human rights and affords meaning to life (affect), as stated in the UN convention for persons with disabilities (2006): "Recognizing the importance for persons with disabilities of their individual autonomy and independence, including the freedom to make their own choices" (p. 3). For individuals with severe/profound ID, the principle of making choices should be applied in everyday activities such as favourite foods, choosing their clothes, occupational and leisure activities.

(c) ABC:- Enriching cognition and literacy, affect and behaviour skills during daily life activities for ***adults*** *with severe/profound ID* (Lifshitz, et al., 2010): This program was designed for adults with severe/profound ID. There have been attempts to improve cognitive, choice-making, and adaptive behaviour skills of adults with severe and profound ID. However, these studies taught participants in separate classes or on an individual basis (1:1 ratio between mediator and trainee). These studies focused on specific skills: improving metacognition by a computer-assisted program (Moreno & Saldana, 2005), receptive communication abilities (Casella, 2004), choosing leisure activities (Browder, Cooper, & Lim, 1998), etc., and lacked a holistic approach that would combine all these skills in everyday natural settings. Our program advocates the ABC, a holistic and broader approach to concurrently improve the cognition and literacy, behaviour and affect of individuals with severe ID through daily life activities via ongoing and varied interactions with their paraprofessional staff. This program was adapted to life situations of adults and implemented for one year in two vocational centres. As mentioned above, the findings indicate that even after the intervention, the direct staff in the control group continued to emphasize only the use of basic skills for immediate performance, without attempting to expand on their meaning by giving basic information such as colour, size, or number of products. For example, during vocational work, consumers were instructed to pack 10 spoons in plastic bags and were provided with a box containing 10 slots to aid them

in counting the spoons. Staff members guided them in inserting the spoons in the slots. In the experimental group, the paraprofessionals counted aloud with consumers and then provided them with opportunities to count alone, an activity not carried out by staff in the control group. Following the intervention, more mediation of autonomy (choice making) was observed in the experimental group. Through their interactions, they succeeded in improving math skills and time orientation.

(d) ABC: Enriching literacy, affect and behaviour skills during daily life activities of persons with ID and AD (Lifshitz & Klein, 2011): One of the serious problems resulting from the increase in lifespan is a concomitant rise in cases of dementia of the Alzheimer type (DAT) among adults with ID with/without DS. Estimates of the age-specific prevalence of dementia in adults with DS have varied widely, from under 10% to over 75% (Zigman, Schupf, Sersen, & Silverman, 1996). This association appears to be due to a triplication of the gene for the beta-amyloid precursor protein (β-APP) which is located on the proximal part of the long arm of chromosome 21 (Goldgaber, Lerman, McBride, Saffiotti, & Gajdusek, 1987).

Several studies have focused on the stressors and sense of burden of the caregivers (families) or staff caring for elderly persons with ID and AD (McCallion, McCarron, & Force, 2005). Caregivers lack knowledge on how to treat and what can be done for persons with ID who have Alzheimer disease, and exhibit problems with memory, space and time orientation. The ABC for adults with ID and AD affords a solution to these questions and fills this void. Mediational parameters can be applied through the interaction between caregivers and persons with ID/AD during daily activities: meal and medication time, work sessions and leisure activities. This ABC for adults with ID and AD is based on the integration of *person-centred cultural approaches,* which emphasize individual identity and selfhood, and the *cognitive rehabilitation approach* (Clare, Wilson, Carter, & Hodges, 2003), which is based on the understanding that, despite the deterioration in memory and other cognitive functions, people with dementia still have the ability to learn new skills and new associations, and to adjust their behaviour accordingly. In line with the CAT and the cognitive rehabilitation approach, the ABC for adults with ID and AD works on mediation of cognition and autonomy during daily life activities in order to improve their functioning in the same areas in which they exhibit deficit (for more details see Lifshitz & Klein, 2011).

For example, Jacob (54 years old) is a person with DS who was diagnosed with early-stage Alzheimer disease four years ago. Based on cognitive rehabilitation theory (Clare et al., 2003), a tailored program with three mediational parameters of the MISC was constructed in order to overcome his weaknesses. The findings indicated that he showed numerous important strengths, including the capacity and motivation for learning new skills. This suggested that he was able to learn new strategies that compensated for his deterioration in short-term memory, and orientation in time and space. Jacob was coping with the onset of dementia by facing up to its impact and trying to adapt.

Conclusions

In line with the SCM and the CAT framework including our empirical studies support the view that all human beings, even people with ID, are capable of change. In this article we indicate the evolution of Feuerstein's work (Feuerstein & Rand, 1974; Feuerstein, Rand, Hoffman & Miller, 1980; Feuerstein, Rand & Rynders, 1988) in a population of ID from vision to reality. Our work shows that individuals with ID, especially at older ages and among those with severe and profound ID, can benefit not only from exposure to concrete information and sensory-based experiences, but also from programs designed to ameliorate impaired cognitive functioning. Despite the limitations imposed by age or disabilities, the concept "self-actualization" can be expanded to include individuals with ID at all levels, even at advanced ages.

Further research

Following Feuerstein's direction and the CAT, our studies and interventions focus on the cognitive ability of individuals with ID. It is recommended to expand research on emotional and social aspects and to examine whether it is possible to alter the emotional and social skills of individuals with ID beyond the limitation of age, aetiology and severity of limitation.

References

Bloom, B. (1970). *Stability and change in human characteristics*. New York: John Wiley & Sons.

Browder, D. M., Cooper, K. J., & Lim, L. (1998). Teaching adults with severe disabilities to express their choice of settings for leisure activities. *Education and Training in Mental Retardation and Developmental Disabilities, 33*, 228–238.

Casella, P. W. (2004). Receptive communication abilities among adults with significant intellectual disability. *Journal of Intellectual and Developmental Disability, 29,* 70–78.

Chicoine, B., & McGuire, D. (1997). Longevity in a woman with Down syndrome: A case study. *Mental Retardation, 35*, 477–479.

Clare, L., Wilson, B. A., Carter, G., & Hodges, A. R. (2003). Cognitive rehabilitation as a component of early intervention in dementia: A single case study. *Aging and Mental Health, 7,* 15-21

Coppus, A. (2013). People with intellectual disability: What do we know about adulthood and life expectancy?, *Developmental Disability Research Review*. 18: 6–16.

Cramer, S.C., Sur, M., Dobkin, B.H., O'Brien, C., Sanger, T.D., Trojanowski, J.Q., Vinogradov, S. et al. (2011). Harnessing neuroplasticity for clinical applications *Brain* 134 (Pt 6):1591–1609.

Devenny, D. A., Hill, A. L., Patxot, O., Silverman, W. P., & Wisniewski, K. E. (1992). Aging in higher functioning adults with Down's syndrome: An interim report in a longitudinal study. *Journal of Intellectual Disability Research, 36,* 241–250.

Facon, B. (2008). A cross-sectional test of the similar-trajectory hypothesis among adults with mental retardation. *Research in Developmental Disabilities, 29*, 29–44.

Feuerstein, R. (2003). Feuerstein's theory of cognitive modifiability and mediated learning. In T. O. Seng, R. D. Parsons, S. L. Hinson & D.S. Brown (Eds.), *Educational psychology, a practitioner-researcher approach* (pp. 59–60). Singapore: Seng Lee Press.

Feuerstein, R. & Falik, F. L. (2010). Theory and research learning to think, thinking to learn: A comparative analysis of three approaches to instruction. *Journal of Cognitive Education and Psychology, 9*, 4–20.

Feuerstein, R., & Rand, Y. (1974). Mediated learning experience: An outline of proximal aetiology for differential development of cognitive functions. *International Understanding, 9-10*, 7–37.

Feuerstein, R., Rand, Y., Hoffman, M. B., & Miller, R. (1980). *Instrumental Enrichment. An intervention program for cognitive modifiability*. Baltimore, MD: University Park Press.

Feuerstein, R., Rand, Y. & Rynders. (1988). "Don't accept me as I am". New York: Plenum Press.

Fisher, M. A., & Zeaman, D. (1970). Growth and decline in retarded intelligence. In N. R. Ellis, P. S. Seigel, I. A. Bjorgen & N. O'Connor (Eds.), *International Review of Research in Mental Retardation, 4*, 151–189.

Glanz, Y. (1989). *Thinking and three-directional functioning* (Hebrew). Ramat Gan, Israel: Reches.

Gold, D.M. (1978). Stimulus factors in skills training of retarded adolescents on a complex assembly task: Acquisition transfer and retention. *American Journal of Mental Deficiency, 67*, 517-526.

Goldgaber, D., Lerman, M. I., McBride, O. W., Saffiotti, U., & Gajdusek, D. C. (1987). Characterization and chromosomal localization of a CDNA encoding brain amyloid of Alzheimer's disease. *Science, 235*, 877–880.

Head, K., Lott, I. T., Patterson, D., Doran, E., & Haier, R. J. (2007). Possible compensatory events in adults with Down Syndrome brain prior to Alzheimer disease neuropathology: Target for non-pharmacological intervention. *Journal of Alzheimer Disease, 11*, 61–76.

Janicki, M. P., & Dalton, A. J. (2000). Prevalence of dementia and impact on intellectual disability services. *Mental Retardation, 38*, 276–288.

Janicki, M.P., & Davidson, P.W. (1999). *The Greater Rochester Area Health Status Survey*. Rochester, NY: Technical Document, Strong Center for Developmental Disabilities.

Katzman, R. (1993). Education and the prevalence of dementia and Alzheimer's disease. *Neurology, 43*, 13–20.

Kauffman, A. S. (2001). WAIS-III IQs, Horn's theory, and generational changes from young adulthood to old age. *Intelligence, 29*, 131–167.

Klein, P. S. (1992). Assessing cognitive modifiability of infants and toddlers: Observations based on mediated learning experience. In H. C. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 233–250). New York: Springer.

Krinsky-McHale, S. J., Devenny, D. A., Gu, H., Jenkins, E. C., Kittler, P., Murty, V. V., Schupf, N., Scotto, L., Tycko, B., Urv, T. K., Ye, L., Zigman, W. B., & Silverman, W. (2008). Successful Aging in a 70-year-old man with Down Syndrome: A case study. *Intellectual and Developmental Disabilities, 46*(3), 215-228.

Lifshitz, H. (2001). Aging phenomena among people with mental retardation in community residence in Israel. *Education and Training in Mental Retardation and Developmental Disabilities, 36*(1), 30-41.

Lebeer, J. (2014).Modifiability and mediated learning in the light of neuroscientific evidence of ecological plasticity, *Transylvanian Journal of Psychology, Special Issue*

Lifshitz - Vahav, H. (in press). Compensation Age Theory (CAT): The effect of chronological age in a population of intellectual disability. *Education and training in intellectual and developmental disabilities* (accepted for publication)

Lifshitz, H., & Merrick, Y. (2003). Ageing and intellectual disability in Israel: A study to compare community residence with living at home. *Health and Social Care in the Community, 11*(4), 364-371.

Lifshitz, H., & Katz, Y. J. (2009). Religious concepts among individuals with intellectual disability: A comparison between adolescents and adults. *European Journal of Special Needs Education, 24*, 183–201.

Lifshitz, H., & Klein, P. S. (2007). Comparison of mediation between paraprofessionals and individuals with intellectual disability: Vocational rehabilitation centres versus special education schools. *European Journal of Special Needs Education, 22* (4), 443–458.

Lifshitz, H., & Klein, P. S. (2011). Mediation between staff–elderly persons with intellectual disability with Alzheimer disease as a means of enhancing their daily functioning – a case study. *Education and Training in Mental Retardation and Developmental Disabilities, 46*, 106–116.

Lifshitz, H., Klein, P. S., & Cohen, S. (2010). Effects of MISC intervention on cognition, autonomy, and behavioural functioning of adult consumers with severe intellectual disability. *Research in Developmental Disabilities, 31* (4), 881–894.

Lifshitz, H., & Rand, Y. (1999). Cognitive modifiability in adult and older people with mental retardation. *Mental Retardation, 37*, 125–138.

Lifshitz, H., & Tzuriel, D. (2004). Durability of effects of instrumental enrichment in adults with intellectual disabilities. *Journal of Cognitive Education and Psychology, 3*, 297–322.

Lifshitz, H., Tzuriel, D., Weiss, I., & Tzemach, M. (2010). New model of mapping difficulties in solving analogical problems among adolescents and adults with intellectual disability. *Research in Developmental Disabilities, 32*, 326–344.

Lifshitz-Vahav, H., Tal, D., Nissim, D., & Nissim, S. (in press). *The new Israeli educational curriculum of students with severe and profound intellectual disability: Theoretical background and program*. Jerusalem: Ministry of Education.

Luftig, R. L. (1987). *Teaching the mentally retarded student, curriculum methods and strategies.* Massachusetts: Allyn Bacon.

Mahncke, H.W., Connor, B.B., Appelman, J., Ahsanuddin, O.N., Hardy, J.L., Wood, R.A Merzenich, M.M., et al. (2006). "Memory enhancement in healthy older adults using a brain plasticity-based training program: A randomized, controlled study." States of America, 103(33): 12523–12528.

McCallion, P., McCarron, M., & Force, L. T. (2005). A measure of subjective burden for dementia care: The Care giving Difficulty Scale - Intellectual Disability. *Journal of Intellectual Disability Research, 49*, 365–371.

Merrick, J. (2010). *Trends in the aging of persons with intellectual disability in residential care centres in Israel, 1999-2010*. Jerusalem: Office of Medical Director, Ministry of Social Affairs.

Mesulam, M. M. (1999). Neuroplasticity failure in Alzheimer's disease: Bridging the gap between plaques and tangles. *Neuron, 24*, 521–529.

Moreno, J., & Saldana. D. (2005). Use of a computer-assisted program to improve metacognition in persons with severe intellectual disabilities. *Research in Developmental Disabilities, 26*, 341–357.

Oliver, C., Crayton, L., Holland, A., Hall, S., & Bradbury, J. (1998). A four year prospective study of age-related cognitive change in adults with Down's syndrome. *Psychological Medicine, 28*, 1365–1377.

Piaget, J. (1970). Piaget's theory. In P. Mussen (Ed.), *Carmichael's manual of child psychology* (3rd edition, pp.103–128). New York: Wiley.

Scarmeas, N., & Stern, Y. (2003). Cognitive reserve and lifestyle. *Journal of Clinical and Experimental Neuropsychology, 25*, 625–633.

.Schalock, R. L. (1996). Re-conceptualization and measurement of quality of life. In R. L. Schalock (Ed.), *Quality of life: Re-conceptualization and measurement* (pp. 123–129). Washington, DC: American Association of Mental Retardation.

Snowdon, D. A., Greiner, L. H., & Markesbery, W. (2000). Linguistic ability in early life and the neuropathology of Alzheimer's disease and cerebrovascular disease: Findings from the Nun study. In R. N. Kalaria & P. Ince (Eds.), *Vascular factors in Alzheimer's disease: Annals N.Y. Academy of Science, 903* (pp. 34–38). New York: New York Academy of Sciences.

Stern, Y., Habeck, C., Moeller, J., Scarmeas, N., Anderson, K. E., Hilton, J., Flynn, J., Sackeim, H., & Heertum, R. V. (2005). Brain networks associated with cognitive reserve in healthy young and old adults. *Cerebral Cortex, 15*, 394–402.

Tzuriel, D., & Galinka, E. (2000). *The conceptual and perceptual analogical modifiability (CCPAM) Test: Closed analogies-instruction manual*. Ramat-Gan: School of Education, Bar-Ilan University.

UN Convention on the Rights of Persons with Disabilities United Nation (2006), New York.

Wechsler, D. (1955). *The range of human capacities (2nd ed.)*. Baltimore: Williams & Wilkins.

White, D. (1969). IQ changes in mongoloid children during post maturation treatment. American Journal of Mental Deficiency, 73, 809-813.

Wilson, R. S., & Bennett, D. A. (2005). Assessment of cognitive decline in old age with brief tests amenable to telephone administration. *Neuroepidemiology, 25*, 19–25.

Zigman, W. B., Schupf, N., Devenny, D. A., Miezejeski, C., Ryan, R., Urv, T. K., Schubert, R., & Silverman, W. (2004). Incidence and prevalence of dementia in elderly adults with mental retardation without Down Syndrome. *American Association on Mental Retardation, 109*, 126–141.

Zigman, W. B., Schupf, N., Sersen, E., & Silverman, W. (1996). Prevalence of dementia in adults with and without Down syndrome. *American Journal on Mental Retardation, 100*, 403–412.

Instrumental Enrichment: impacts upon learners who are deaf

DAVID S. MARTIN [1]

Abstract

Feuerstein's Instrumental Enrichment (FIE) has positively affected the learning capacity of many populations; among those have been the effects with deaf and hearing impaired learners. The long history of negative expectations for deaf learners' intellectual potential is reviewed, together with later significant breakthroughs from meta-analytic research. Two reasons are provided for the relative rarity of implementation of FIE in deaf education. However, the often little-understood differences in the learning styles of deaf vs. hearing learners can explain how FIE has a uniquely relevant application to the cognitive needs of learners who are deaf. A summary of research studies on cognitive intervention programs provides a context for the introduction of FIE as a systematic and explicit intervention in different learning environments involving deaf learners; a synthesis of these studies indicates significant positive outcomes for FIE in that context in North America. A detailed description of a comparative international study of deaf learners in two countries further indicates that these positive effects may also be cross-cultural. A view of ongoing current and future training and implementation of FIE for deaf learners shows that FIE will persist as a cognitive tool in the hands of educators of the deaf.

Keywords

Deaf, Hearing impairment, Cognition, Feuerstein Instrumental Enrichment Programme, cognitive processing

1. Professor/Dean Emeritus, Gallaudet University, Washington D.C., USA. Adress of correspondence: 10 Colonial Farm Circle, Marstons Mills, Massachusetts, USA. Email: davidmartindr@aol.com

Introduction

In the well-deserved issue of this journal to honor the memory and monumental works of the outstanding cognitive psychologist, Prof.Reuven Feuerstein, the impact of his Instrumental Enrichment program (FIE) (Feuerstein, 1980) on learners from many different populations is highly appropriate for us to examine—in this instance, the impacts upon the learning capacities of learners who are hearing impaired. Because deafness is considered to be a "low-incidence disability" due to its relative rarity in most populations, the number of trainings and implementations of the FIE program for the needs of deaf learners have necessarily been more limited than for many other populations, e.g., typically-developing learners, learning-disabled learners, and developmentally challenged learners, to name only some.

However, a number of empirical studies since the late 1970's have documented the positive effects of the program on this special population. Cognitive intervention programs in general have been applied only from time to time in deaf-education settings for one principal reason—the overall focus among educators of the deaf and hard of hearing for many decades has been on enabling them to attain some form of basic literacy for their students, with the result that relatively little time has been devoted to other subjects in the curriculum. An important factor is that more than 90% of deaf learners are born to hearing families and thus grow in their early years without benefit of any language. The profoundly or severely deaf child cannot hear and thus is blocked from auditory input, and the great majority of hearing parents of deaf children until recently did not learn sign language to use with their deaf child—in other words, these children have not had an opportunity to develop another modality of expressive and receptive language, i.e., visual instead of auditory, until and unless they have entered a formal school program which uses sign language (often not until age 5 after several critically important developmental years have been neglected.

Why, then, has the adoption of FIE been relatively inconsistent in deaf education? Two reasons may be found. First, it is not surprising that the training and implementation of FIE among classroom teachers for deaf students requires an unusual commitment in order to be willing to "sacrifice" valuable literacy- development time for a focus on thinking strategies in the classroom. The fact is, however, that the research reported in this article indicates that the faithful implementation of FIE among deaf learners actually

provides the cognitive prerequisites necessary for literacy, although not in an obvious way at first; for example, the development through the FIE program of such thinking skills as precision, comparison, analysis, systematic approaches to problem-solving, and decoding (among others) has a direct positive relationship to the process of becoming literate. Therefore, adoption of FIE by teachers of deaf students requires some initial risk-taking in order to "make time" for a cognitive-strategy focus. The studies reported below provide evidence that such "risk-taking" is indeed worthwhile and yields valuable eventual dividends to the deaf learner.

A second reason for inconsistent adoption of FIE is found in nearly all potential FIE classrooms (regardless of the students' special needs) -- how to "justify" taking classroom time for cognitive intervention when a program such as FIE does not clearly appear to "fit" the subject matter of the curriculum in any obvious way—its content is not history, science, social studies, literacy, etc. FIE is deliberately designed to be generally content-free. It is not clear at first, then, to the uninitiated classroom teacher how cognitive strategies can possibly assist with any learning since the effects are indirect and not immediate. For nearly all classroom teachers, then, adopting FIE after the required extra training as a mediator is a kind of "act of faith" by teachers. And in the USA, many states are tying teacher evaluation to student performance on annual examinations, thus putting more pressure on teachers to avoid deviating from the regular curriculum. For both of these reasons, then, it is understandable that the implementations of FIE in classrooms with deaf students has been somewhat limited.

In the pages which follow, we provide first a summation of the historical view of attitudes toward the intelligence of deaf learners (a sad chapter in educational history), followed by a summation of a number of research studies carried out with deaf learners and several cognitive interventions including FIE, followed in turn by a detailed description of a particular international comparative study of FIE with deaf learners, and then we finish with a cautious look at the potential future for applications of the FIE program in the field of deaf education, including current projects under way with deaf learners for whom data are yet still to be collected.

All of these activities are testimony to the legacy of Reuven Feuerstein and his contributions to the education of all learners.

Historical overview

As in some other special-educational domains, attitudes toward deaf learners have a long and, for the most part until recently, sad history. We can, through inference, trace back some of these attitudes into antiquity. For example, in the Old Testament is an admonishment to the Hebrews not to curse the deaf; it is a small leap to infer that such an admonishment would not have been given if hearing citizens had not in fact been cursing the deaf—forcing deaf persons to be hidden or remain relatively isolated from the rest of society.

Later we find that Aristotle—that giant of thought from Ancient Greece—considered the ear to be the organ of instruction. Again, it is a small leap to infer Aristotle's probable view that if a person could not hear, then she/he could not be taught. Interestingly, if we jump forward in Western European history, we find that in the 16th century and afterward, the right conclusion was drawn for the wrong reasons—some successful attempts had been made by that time in some Western European countries to teach moderately deaf persons to speak (probably persons with enough residual hearing to make speech imitation possible for some). Thus it was then concluded that, after all, some deaf persons could in fact be taught and therefore may have "intelligence." Again, we see the confusion by the hearing world that the ability to articulate speech correlates with intellectual potential.

Then we pass through a period of historical backsliding once again. If we jump ahead to the early 20th century, we find that in the 1920's a report from the USA's National Research Council (an arm of the then-young National Academy of Sciences) said that deaf learners were two-to-three years "retarded" (National Research Council, 1925); the use of that term was indeed unfortunate because it could be taken as referring to mental retardation as a label, which then implied lowered expectations. The report probably meant that deaf learners were "behind" their hearing counterparts, which would be understandable if deaf persons had been prevented from linguistic experiences. Later in the 20th century, we find that even some well-regarded special educators were pronouncing that deaf learners were intellectually "inferior" (Pintner, 1941), and only capable of concrete, rather than abstract, understanding (Myklebust, & Brutton, 1953).

In fact, it was not until the 1960's that two breakthroughs occurred, after centuries of misunderstanding and lowered expectations. One educator

published a research article declaring (finally) that no differences existed between deaf and hearing learners' ability to conceptualize (Rosenstein, 1961). Then a psychologist (Furth, 1964; 1973) from outside the field of deafness published an important paper in which he stated that the problem was not with deaf persons' performance, but rather was due to the tests that were being used to assess them—correctly putting his finger on one of the critical problems in the field. Shortly afterward, another highly regarded scholar in the field of deaf education (Vernon, 1968) carried out a meta-analysis of a group of research studies that had been done earlier on particular cognitive skills in deaf learners; he concluded that, when considered together, the body of research now showed that deaf learners have the same cognitive potential as hearing learners, even though they demonstrate some different strengths and learning styles from their hearing peers. The key word here is "potential"—meaning that deaf learners could achieve on a par with hearing learners, but that certain actions had to be taken in order to achieve that equity. This finding laid the foundational rationale for adopting the Feuerstein view of intelligence as dynamic, not static, in deaf education as in all other realms of education.

In the matter of learning styles, it has been inferred (Marschark & Wauters, 2003) that deaf learners are not simply hearing learners who cannot hear. The use of a visual language, such as American Sign Language, "wires" the brain in a different way, such that many deaf learners have a relative strength compared to hearing learners in simultaneous processing—because the brain needs to process visual communication in a simultaneous manner. On the other hand, hearing learners who use an auditory language tend to be more adept than deaf learners in sequential processing because one processes an auditory language sequentially.

The powerful conclusion that deaf learners have a full range of cognitive potential has still not completely permeated the field of deaf education, but specific attempts were then made during the latter 1970's and beyond to carry out pro-active cognitive interventions with deaf learners as means of providing the cognitive strategies that they were missing, so that their potential could indeed be realized. FIE has been one of the primary tools in a number of those interventions, as we shall review below. Those efforts continue at the present time and represent a most hopeful trend in deaf education.

Cognitive interventions

Deaf cognition has been subjected to many years of empirical study. But with the establishment of the principle that deaf learners have the same range of cognitive potential as hearing learners (e.g., Furth, 1964; Vernon, 1968; Meadow, 1980), a number of studies occurred during the 1980's and 1990's in relation to the enhancement of cognitive development in the deaf learner.

The studies have involved the use of several different programs of cognitive-strategy instruction, a number of which used the FIE Program, to investigate the effect of explicit and systematic classroom focus on the teaching of higher-order cognitive strategies and their application to school subject matter.

A study by Rembert (1985) used the Philosophy for Children program with deaf students and found that students learned to express themselves more clearly in interpersonal communication, increased in understanding of meaning in their reading comprehension, and improved in their acceptance of others' opinions; these results are understandable because of the emphasis on dialogue in that program.

Let us look now at studies which explicitly included FIE. In one of these studies (Berchin, 1991), eighth-grade students at the Lexington School for the Deaf in New York City used the FIE program over a period of four years. It was found that FIE students on the Stanford Achievement Test for Reading and Mathematics Problem-Solving, after using FIE, showed the following increases when compared to national data that indicate an average growth of about 3 months per year without using FIE: 22% of the students increased 3 or more grade levels in Reading Comprehension, 14% increased 2 grade levels, and 33% increased one grade level; on Mathematical Problem-Solving, 36% of the students increased 3 or more grade levels,17% increased 2 grade levels, and 19% increased 1 grade level. These data are noteworthy in light of the fact that there were 24 different home languages in students' families, and 80% of the students qualified for governmental assistance as a result of family poverty (Keane, 1985). Keane found that when deaf students have FIE experiences, mediation results in measurable cognitive modifiability. Keane and Kretschmer (1983) had also designed a study in which an experimental group of profoundly deaf students from hearing families were contrasted with a similar group of controls; the experimental group were exposed to mediated intervention on Feuerstein's Learning Propensity Assessment De-

vice (LPAD). The experimental group performed significantly better in transferring their learning on defined cognitive parameters.

Another study by Dietz(1985) combined the use of FIE with the computer program LOGO, and found that students became more independent, were more persistent in dealing with challenging problems in mathematics, used better planning behavior, were more willing to explore on their own without needing continuous feedback from their teachers, and developed more positive attitudes toward school.

Other studies which support the acquisition of cognitive strategies by deaf learners through FIE's mediated-learning interventions include those by Krapf (1985) and Parasnis & Long (1979).

A study with high-school age deaf students (Martin & Jonas, 1986) was designed to examine the effects of intervention using FIE methods and materials. At the Model Secondary School for the Deaf(MSSD) in Washington, D.C., six FIE instruments (analytic perception, comparison, projection of visual relationships, spatial relations, instructions and classification) were used over a two-year period with an experimental group of secondary-level deaf//hard of hearing students by contrast with a similar group of control-group students. The specially trained teachers at least twice a week incorporated a series of visual, verbal, and geometric activities into regular subject matter; helped students solve these problems; conducted metacognitive discussions; and then discussed how the students' mental strategies within these problems would be used in subject matter.

The gain by the FIE group on the Raven's Standard Progressive Matrices (Raven, 1960) exceeded that of the control group at a .02 level of statistical significance. The results of the Reading Comprehension subtest of the Stanford Achievement Test for the Hearing-Impaired (SAT-HI) indicated that the experimental group exceeded the control group at a significance level of $p<.05$; FIE students improved by 15.6 scaled points. This significant improvement in reading comprehension can be explained by the added focus through FIE on the prerequisite literacy skills of comparison and projection of relationships. The FIE instructional emphases on precision, taking time to think (restraint of impulsivity), and checking one's own work would further explain this important gain in the FIE group of students. Scores of experimental subjects on the SAT-HI mathematical computation and concepts subtests indicated a statistically significant difference demonstrating greater progress by FIE students in the acquisition of math concepts by the end of

the experimental period as compared to the control group. In addition to the use of the Raven's Matrices and the SAT-HI, real-world problem-solving situations were presented for written responses. Results indicated that FIE students improved in thoroughness, detail, and sequence in their responses to problems when compared to the non-FIE students. In addition, let us refer back to the earlier statement that many students who have been profoundly or severely deaf from an early age and are users of a visual language, tend to experience challenges in sequential vs. simultaneous processing. The fact that FIE addresses sequencing would at least partially explain some of the improvement of the experimental students in literacy because the relatively weaker area of sequential processing has been addressed.

Finally, teachers other than the FIE teachers were asked to rate all experimental and control group students' cognitive behavior before the beginning of the experimental period and again near the end of the project, using a five-point scale of behaviors which reflected the major goals of FIE. Because the reporting teachers were *not* those involved in the teacher–training group, they had no specific preconceived expectations for any changes in student behavior. The rating of experimental group students by teachers other than those in which that group had their FIE experiences found the following trends in experimental students:

- A tendency to move directly to expected tasks.
- Giving relevant and complete answers.
- Increased willingness to help others in class.
- An increase in working well with others in a group.
- An increase in "consideration of others' feelings" and increase in "listening" behavior.
- A decrease in impulsivity.
- A reduction in involvement in non-productive arguments.

Positive results from another FIE intervention were also reported from implementation of FIE at the Western Pennsylvania School for the Deaf (WPSD) (Craig, 1987). As with the MSSD study, intervention took place in classes of students; thus, the classroom was again the unit of intervention, and students were not individually assigned randomly to treatment groups. Over a two-year period, secondary-level students in the experimental classes were provided with systematic instruction in cognitive skills for at least two class periods per week using FIE, while the comparison groups received only the

regular academic instruction (e.g., reading, language, mathematics) which was usually scheduled at that time. The WPSD study included 20 experimental and 20 control subjects. Results from the WPSD study (Craig, 1987) showed that the students trained in FIE made significantly higher gains than control group students on the Reading Comprehension subtest of the SAT-HI. Over the 2 years, the FIE-trained group made a scaled score gain of 14.7, compared to the non-FIE group gain of 9.5 ($t = 3.83$; $p < .01$). For the FIE group, this result represents a Grade Equivalent (GE) gain of 1.68 or (0.84 per year), almost tripling the average yearly gain in SAT-HI Reading Comprehension reported for deaf students nationwide who have not experienced the FIE intervention (Trybus & Karchmer, 1977). The WPSD experimental group also gained significantly higher scores on the Minnesota Paper Form Board (a measure of spatial problem-solving) than did the controls ($t = 3.23$; $p < .05$). .

Other successful implementations of the FIE program have taken place at The Learning Center for the Deaf in Framingham, Massachusetts and at the North Carolina School for the Deaf at Morganton. For digests of studies related to cognition and deafness, including interventions through FIE and other techniques, see Martin (Ed.) (1985) and Martin (Ed.) (1991).

An internatonal study

The above studies have largely occurred in North America, within the framework of a culture that values independence, originality, and systematic approaches to problem-solving. An important question arises as to the cross-cultural applicability of these same effects on deaf learners in other countries. Other cross-cultural studies of thinking in education provide additional perspectives and are summarized in Martin, Craft, & Zhang (2001).

A cross-cultural international comparative study using the FIE Program was then devised, involving cohorts of deaf students in the United Kingdom and the People's Republic of China (Martin, Craft, & Zhang, 2001).

The major objective of this investigation was determining the degree to which the positive effects of cognitive-strategy instruction for deaf learners are international or cross-cultural, given similar conditions of teacher training, application of methodologies, and application of specific material. Cognitive strategies in this study followed the Feuerstein methods of specific practice in particular thinking skills (e.g., comparison, categorization, etc.) in

which the learner first uses content-free paper-and-pencil exercises to learn about and rehearse the strategy, followed by metacognitive discussion about the process just used, and practice in applying that particular strategy to some aspect of subject matter study within the regular curriculum.

The procedure in this study first established a teacher-training sequence which included a theoretical overview of critical and creative thinking skills, followed by a discussion of some recent theoretical topics in the field such as multiple intelligences, divergent thinking, cognitive modifiability, metacognition, and the role of teacher as cognitive mediator. The sessions continued with the demonstration of particular critical thinking activities adapted from the work of Swartz and Parks (1994) in addition to FIE. Specific cognitive strategies taught to the teachers included comparison, categorization, sequencing, creating instructions, and finding multiple solutions to the same problem. Themes of the critical thinking and problem-solving activity in the teacher-training sessions involved sequencing, comparison, categorization, cause-and-effect, prediction, and identifying reasons and conclusions.

Sessions related to the teaching of creative thinking made use of aspects of the work of Craft (1997), Gardner (1980), and Sternberg & Lubart (1991). Teacher-training tasks involved reflecting on the creative process, overcoming barriers to creativity, the importance of teachers as adults freeing their own creativity in order to become teachers of creative thinking, and developing and sharing of model classroom activities built on such themes as risk-taking, applying innovations, multiple possibilities, and what-if situations.

The materials and teaching procedures which the teachers used with the experimental classes consisted of some non-verbal paper-and-pencil exercises, some discussion-prompter topics, some group investigation tasks involving the solving of a problem or the creation of an innovative idea, and some enactive activities in order to illustrate an abstract idea. FIE activities formed the majority of the classroom activities by these FIE-trained teachers.

In each implementation for each country, teachers were asked to incorporate planned explicit thinking activities (problem-solving/critical and creative) over a 6-month period between two and three times per week, with an average of 30 minutes on each occasion devoted to explicit thinking-skill activities. The results of this international comparative study were:

1. The lack of difference between the two groups—England (presumed to reflect a cultural base that is similar to the USA) and China—in reasoning skills, seems to indicate that although the style of problem-solving may be different, the outcomes in the present study are similar across the two countries and the USA, in reference to the Martin and Jonas (1985) study cited earlier.
2. The complexity of demands on some of the critical and creative thinking activities involved multiple steps—problem-identification, development of alternatives, selection of most appropriate solutions, and defense of the solution chosen. The study provided relatively little time for the acquisition of those complexities (six months); it is to be expected that any results obtained in such a short period would be notable, given that the discoveries, insights, and refinements needed may well require further time.
3. In both the China and England groups, the cognitive activities appear to have resulted in heightened student interest, as evidenced by both teacher reports and classroom observations; such an effect could have a further salutary effect on student interest in school in general.
4. Student use of cognitive vocabulary appears to be an unplanned effect of the thinking activities, but it is understandable because discussion in the intervention program often refers to cognitive processes—a metacognitive effect. Teachers report that this terminological use was spreading also to the times of the school day other than when thinking strategies were the overt explicit emphasis.
5. While the study did not explicitly intend to compare deaf and hearing learners within the same sample groups, nonetheless an artifact of seeking participating teachers in the England cohort resulted in a combination of deaf and hearing learners in those groups. Their pre- and post-test data were analyzed both as a combined group, and separately (deaf vs. hearing). A striking result is that there were no measurable differences in the outcomes for deaf vs. hearing learners. This outcome is particularly encouraging inasmuch as it adds to the evidence that deaf learners have a potential which is similar to hearing learners.

6. The research design originally posited that the factor of communication modality might make a difference in outcomes----that the use or non-use of sign language would affect the results. It was known in advance that teachers in England (and in the previous study in the USA) used sign language regularly in the classroom with their deaf learners, while in China the teachers emphasized oral methods with some sign-supported speech. However, as was indicated in the report of the results, the experimental teachers in China actually adopted considerably more regular use of sign language than they had done before; this serendipitous result was attributed to the fact that during their training period, the trainer had consistently modeled the use of sign language.
7. Similarly, the research design had posited that the view of the learner might affect the outcomes of cognitive-strategy instruction; it had been previously established through observation that teachers in England (and in the earlier study in the USA) approached instruction with a fundamentally constructivist viewpoint, seeing the learner as participatory and fostering significant student-student and student-teacher interaction, while in China the dominant style had been didactic with the teacher being the source of knowledge and the learner as the recipient. However, the China experimental teachers during the experimental period adopted a significantly more participatory style, as recorded by the outside observers using the Classroom Observation Scale (Winocur, 1991). Again, the modeling of this approach in the teacher-training period could be the origin of this change.

The above studies with FIE, when taken together, demonstrate that such explicit classroom intervention with appropriately re-trained teachers, use of appropriate methodology, and use of specially designed materials, result in measurable positive effects on specific cognitive skills in deaf learners when compared to deaf students who do not have this classroom experience.

The overall conclusion from all of these cognitive intervention accounts is that not only is it clear that deaf students have cognitive potential which can be realized, but also that the FIE program is one of the prime methods of intervention which has led to these educational successes.

The present and future

Efforts to pro-actively enhance the cognitive development of deaf and hard of hearing learners continue. Among those is an on-going project at the National Institute for the Deaf in Worcester, South Africa. In that extensive project, more than 35 teachers have been trained by the author at the same school in either FIE Basic or FIE Standard; they are implementing the program with populations who come not only from South Africa but also neighboring countries where they would have no opportunity for cognitive education. The project has a full-time on-site FIE Coordinator—an essential component to ensure that teachers have a support system as well as having a professional with full expertise who can provide models for mediation and assist the teachers with their implementation for consistency across the institution. Data on this project are being collected as part of a doctoral dissertation research.

Separately, at a smaller school for the deaf in Western Massachusetts, USA, several teachers have begun training in FIE Basic for implementation with pre-school and young elementary-age students during 2015. At another larger school for the deaf in Connecticut, planning is under way for faculty professional development in FIE in the next two academic years; interestingly, this project has resulted from the fact that the Superintendent had been a deaf student who had his own FIE experiences as a student himself at one of the New York-based FIE projects during the 1980's—thus, a second generation is planning to perpetuate the effects of the program. Other projects with deaf learners may be under way elsewhere.

The timeliness for inclusion of cognitive strategies in teacher education has been underlined at the international level. Davila (2000), in the keynote presentation at the 19th International Congress on Education of the Deaf, listed among the current needs in the field that teachers must help deaf learners with reasoning and problem-solving skills. Marschark (2000), in a review of what is and is not known in the field of deaf education today, stated that without an understanding of the full complexity of cognitive abilities, special education teaching methods can "never be special". Svartholm (2000), in discussing how teachers must make a "bridge" between sign language and the local written language, stated that teachers need "extra training" in critical thinking.

A clear curricular implication emerges: regular and systematic infusion of cognitive strategies should become a part of the curriculum for deaf learners at all ages. Methodologies for infusing higher-order thinking now should also become part of the repertoire of not only current in-service teachers through professional development, but also of teachers-to-be during their pre-service preparation. In turn, teacher-education faculty must themselves become adept at such strategies and knowledgeable about their importance in order to prepare their future teachers in these strategies. FIE is clearly the most widely tested and logical tool for this work with deaf students.

Acknowledgements

We salute Reuven Feuerstein for his deep contributions to the improvement of the learning capacities of all learners, without whom much of the above achievement would not have been possible.

References

Berchin, J. (1991). Spontaneous comparative behavior and categorization: The links between mediated interaction and reading comprehension. In Martin, D. S. (Ed.), *Advances in cognition, education, and deafness* (pp. 265-270). Washington, D.C.: Gallaudet University.

Cai, J. (1997). *An investigation of U.S. and Chinese students' mathematical problem- posing and problem-solving.* Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL, March 24-28.

Craft, A. (1997). *Can you teach creativity?* Nottingham, England: Education Now.

Craig, H. (1987). Instrumental enrichment: Processes and results with deaf students. *Thinking Skills Newsletter.* Pennsylvania Department of Education.

Davila, R. (2000). *Education of the deaf in the new millennium: Assessing the past and projecting into the future.* Keynote address at the 19th International Congress on Education of the Deaf, Sydney, Australia.

Dietz, C. H. (1985). Improving cognitive skills in deaf adolescents using LOGO and Instrumental Enrichment. In Martin, D. S. (Ed.) *Cognition, education, and deafness.* Washington, D.C.: Gallaudet University Press, pp. 180-183.

Feuerstein, R. (1980). *Instrumental Enrichment.* Baltimore: University Park Press.

Furth, H. (1964). *Thinking without language.* New York, Free Press.

Furth, H. (1973). *Deafness and learning: A psychological approach.* Belmont, CA: Wadsworth Publishing Company.

Gardner, H. C. (1980). *Frames of mind.* Cambridge: Harvard University Press.

Keane, K. (1985). Applications of Feuerstein's mediated learning construct to deaf person. In Martin, D.S. (Ed.) *Cognition, education, and deafness.* Washington, D.C.: Gallaudet University Press, pp. 141-147.

Keane, K. J. & Kretschmer, R. E. (1987). Effect of mediated learning intervention on task performance with a deaf population. *Journal of Educational Psychology*, 79, (1), 49-53.

Krapf, G. (1985). *The effects of mediated intervention on advance figural analogic problem-solving with deaf adolescents: Implications for dynamic assessment.* Unpublished doctoral dissertation, Temple University, Philadelphia, PA.

Marschark, M. (2000). *Developing deaf children or deaf children developing?* Plenary presentation at the 19th International Congress on Education of the Deaf, Sydney, Australia.

Marschark, M. & Wauters, L. (2003). Cognitive functioning in deaf adults and children. In *Oxford Handbook of Deaf Studies, Language, and Education*. Oxford: Oxford University Press.

Martin, D.S., Craft, A., & Zhang, N.S. (2001). The impact of cognitive-strategy instruction on deaf learners: An international comparative study. *American Annals of the Deaf*, 146 (4), 366-376.

Martin, D. S., & Jonas, B. S. (1985, January). Cognitive improvement of hearing-impaired high school students through instruction in Instrumental Enrichment. *Resources in Education*. ERIC Document Reproduction Service No. ED247726. Also in Martin, D. S. (Ed.), *International symposium on cognition, education, and deafness: Working papers* (Vol. II) (pp. 477-571). Washington, D.C.: Gallaudet University Press, 1984.

Martin, D. S., & Jonas, B. S. (1986). *Cognitive modifiability in the deaf adolescent*. Washington, D.C.: Gallaudet University. ERIC Document Reproduction Service No. ED276159.

Martin, D.S. (Ed.) (1985). *Cognition, education, and deafness*. Washington, D.C.: Gallaudet University Press.

Martin, D.S. (Ed.) (1991). *Advances in cognition, education, and deafness*. Washington, D.C.: Gallaudet University Press.

Meadow, K. (1980). *Deafness and child development.* Berkeley: University of California Press.

Myklebust, H., & Brutton, M. (1953). A study of visual perception in deaf children. *Acta Oto-Laryngologica, Supplementum,* 105.

Parasnis, I., & Long, G.L. (1979). Relations among spatial skills, communications skills, and field dependence in deaf students. *Directions, 1,* 26-37.

Pintner, R., Eisenson, J., & Stanton, M. (1941). *The psychology of the physically disabled.* New York: Crofts & Company.

Raven, J. C. (1960). *Standard progressive matrices.* New York: Psychological Corporation.

Rembert, R. (1985). Philosophical Inquiry among hearing-impaired students. In *Cognition, education and deafness*. Washington, D.C.: Gallaudet University Press.

Rosenstein, J. (1961). Perception, cognition and language in deaf children. *Exceptional Children, 27* (3), 276-284.

Sternberg, R., & Lubart (1991). Creating creative minds. *Phi Delta Kappan, 72* (8), 608-614.

Svartholm, K. (2000). *Bilingual-bicultural approaches to educating deaf students*. Paper presented at the 19th International Congress on Education of the Deaf, Sydney, Australia.

Swartz, R., & Parks, S. (1994). *Infusing critical thinking into elementary instruction*. Pacific Grove, CA: Critical Thinking Press.

Trybus, R. J., & Karchmer, M. (1977). School achievement scores on deaf children. *American Annals of the Deaf, 122*, 62-69.

Vernon, M. (1967). Relationship of language to the thinking process. *Archives of Genetic Psychiatry, 16* (3), 325-333.

Winocur, S. L. (1991). Classroom observation checklist. In Costa, A. (Ed.), *Developing Minds.* Alexandria, VA.: Association for Supervision and Curriculum Development.

Neuro-teaching in Primary School. The principles of Feuerstein's mediated learning integrated into school curriculum[1]

CRISTINA VEDOVELLI [2]

Abstract

The aim of this experimental research is to examine Reuven Feuerstein's educational theory.

By expanding on theories from Piaget and Vygotsky, Feuerstein described a method to teach students how to study through the development of an active structural approach. This is effective for learning because it develops habits for seeking novel strategies when faced with new and complex problems.

The study, after analysing the international literature on the application of the method in Primary School, investigates one of the problems arising from the examination conducted so far: why isn't the Feuerstein's Instrumental Enrichment process consistently affects student performance in all subjects always?

The assumption of this research is that the Feuerstein program cannot influence the academic performance if it is not integrated into the school curriculum. It can be assumed that if the Feuerstein principles of mediated learning were applied to all subjects, a neuro-curriculum can be developed, resulting in a significant improvement in the school performance.

The study consists of a two-year quasi- experiment in a Primary School (2013-2014, 2014-2015). 82 students in the fourth and fifth grades and four IE (Instrumental Enrichment) trained teachers were involved. They were divided into four independent groups (which are equivalent to four classrooms): two are experimental and two are for comparison. Quantitative and qualitative assessment tools will be used before and after the process.

Keywords

cognitive education, mediated learning experience, effect study, teachers attitudes, primary school education, neurocognitive intervention, metacognition

1. This paper was presented at the European Conference on Education 2014 in Brighton and published earlier in the Proceedings with ref:

2. University of Sassari, Italy. Address of correspondence: crvedovelli@tiscali.it

Introduction

This research project is about a process for integrating cognitive education into a Primary School curriculum. Specifically, it is focused on a complete and systematic program that allows the transfer of knowledge through concrete pedagogical acts: the Feuerstein program. It is a comprehensive learning process that integrates, systematizes and harmonizes within itself different approaches: cognitive, meta-cognitive and psychosocial. The Instrumental Enrichment's (IE) offers a two-fold approach: to intervene when deficient cognitive and metacognitive functions are identified and to stimulate the affective-motivational component of learning through the care of the educational relationship. According to Feuerstein, is not sufficient to simply focus on deficient thinking processes, is necessary to create conditions for the reconstruction of a student's sense of competence and self-esteem, arouse emotions, feelings, and projects that build confidence to face the life's challenges (Vanini, 1999).

Feuerstein's method is a method *to teach how to learn*. The main objectives are:

- to develop an active structural approach which is effective for learning
- to encourage habits for a continuous exploration to identify flexible strategies when facing new and complex problems
- to continue the process of self-expansion of a person's intellectual potential.

Feuerstein's program is based on Piaget's theory about the stages of cognitive development of the child (Piaget, 1965), but it goes beyond that, and on Vygotsky's theory about development potential (Vygotsky, 1986). It is builds on two theoretical principles: the cognitive modification and the learning mediation

According to Feuerstein, brain structures can be modified. Researchers in neuroscience have confirmed this fact. Environmental stimuli, when appropriate, can modify the synapses network and through repeated efforts can become denser and thus aid learning. Knowledge is the matrix of thought. Feuerstein vision moves beyond the position of Piaget and advances towards Vygotsky's theories. An individual's ability to gain the maximum benefit from environmental stimuli is determined by the type of mediated learning expe-

rience (MLE) to which he was exposed. Critical to the MLE process is the mediator, who facilitates the environmental stimulus and the subject. The mediator should strive to make every encounter an opportunity for growth, development and change (Feuerstein R., Feuerstein R.S., Falik e Rand, 2008).

A teacher transmits knowledge and skills on the assumption that the student is capable of learning, and that if the student does not succeed, it is the fault of the teacher. The mediator, however, is concerned with the learning process rather than the result. Feuerstein, attributing to "*the teaching quality and learning experience the main responsibility for the learner's development*" (Vanini, 2003, p. 29) raises many questions about the school's and teacher's role in student success.

The Instrumental Enrichment consists of two parts: the program and the methodology. The program consists of 14 tools, 500 sheets in total. Each tool focuses on different cognitive functions. All programs require 300 hours of application. This has been an issue because in Primary School it is difficult to add many hours to the school curriculum or remove students from the classroom. However, the ideal process would be to integrate the methodological issues into the school curriculum to build a cognitive educational curriculum or *neuro-curriculum*.

Methodological aspects include:

1. The **cognitive map**: before the lesson begins the teacher analyses the task by several criteria: content, language, cognitive functions, cognitive operations, level of complexity, level of abstraction, and level of expected efficiency.

Table 1.
The Cognitive Map

COGNITIVE MAP		
Name:	**Date:**	**Test/Activity:**
CONTENT	What is this task about?	
MODALITY	What are the "languages"?	
THE COGNITIVE FUNCTIONS: *input* *elaboration* *output*	Which are cognitive functions involved in this task?	
THE COGNITIVE OPERATIONS	Which cognitive operations are required in this task?	
LEVEL OF COMPLEXITY	What is level of complexity (elements number, colours, tables, graphs… on the page)?	
LEVELS OF ABSTRACTION	Is this a concrete or abstract task? What is the level of abstraction?	
LEVEL OF EFFICIENCY	What is the level of performance that I expect from pupils?	

(Feuerstein R., Feuerstein R.S., Falik e Rand, 2008)

2. The **lesson plan**: in stages four and seven the children work individually. In all other stages the teacher and the children work together to identify the elements and objectives of the task and they discuss strategies to solve the task
   This part is a spoken lesson. At the end of the task the teacher helps the children to generalize what they have learned in other situations.

Table 2.
The Lesson Plan

LESSON PLAN
1. Overview of observation task
2. Identification and precise definition of objectives
3. Prediction for any difficulty 'and anticipation of possible strategies
4. Individual work and individualized mediation
5. Discussion, analysis of strategies, processes and errors
6. Clarifying the specific terms
7. Individual work and individualized mediation
8. New discussion on strategies, processes and errors
9. Generalisation
10. Bridging

(Vanini, 2003)

3. The **list of cognitive functions**: this list of intellectual roles is very important for monitoring children's cognitive progress.

Table 3.
The list of cognitive functions for teacher

INPUT	ELABORATION	OUTPUT
Clear perception	Accurate definition of the problem	Using clear and precise language
Systematic exploration	Selection of relevant cues	Thinking things through before responding
Precise and accurate labelling	Internalization of information	Waiting before responding
Well-developed orientation in time and space	Planning behaviour	Staying calm
Conservation of constancies	Broad mental field-remembering	Precision and accuracy in communicating data and information
Capacity to considerer more than one source of information	Recognizing and understanding relationships	Clear visual transport
Need for precision, accuracy and completeness in data gathering	Spontaneous comparative behaviour	Adequate verbal tools
	Categorizing Inferential-hypothetical thinking	Projection of virtual relationship
	Using logic to arrive at and defend conclusion	
	Spontaneous summative behaviour	
	Adequate verbal tools	

(Feuerstein R., Feuerstein R.S., Falik e Rand, 2008)

In my research I created an easier list of cognitive functions for the children to allow them to self-monitor their cognitive progress.

Table 4.
The list of cognitive functions for students

I LOOK THE TASK	**I THINK THE TASK**	**I DO THE TASK**
Attention and concentration Staying calm To observe To listen To read To understand what I observe, listen and read To specifically name Orientation in space and in time	To define the problem To identify important data To expand mind's space To compare To reason To plan To "imagine vision" Be sure that the answer is right To predict consequences To communicate the need for help To find the key concepts	To communicate clearly Be accurate To control movements To overcome block situations Be sure of themselves

(Vedovelli, 2014)

4. The **parameters of learning mediation**: The teacher has to use this intercession during the lesson to promote learning.
   Main mediations are: intentionality, mediation of transcendence and of meaning. Other mediations are linked to occasions that occur during the lesson.

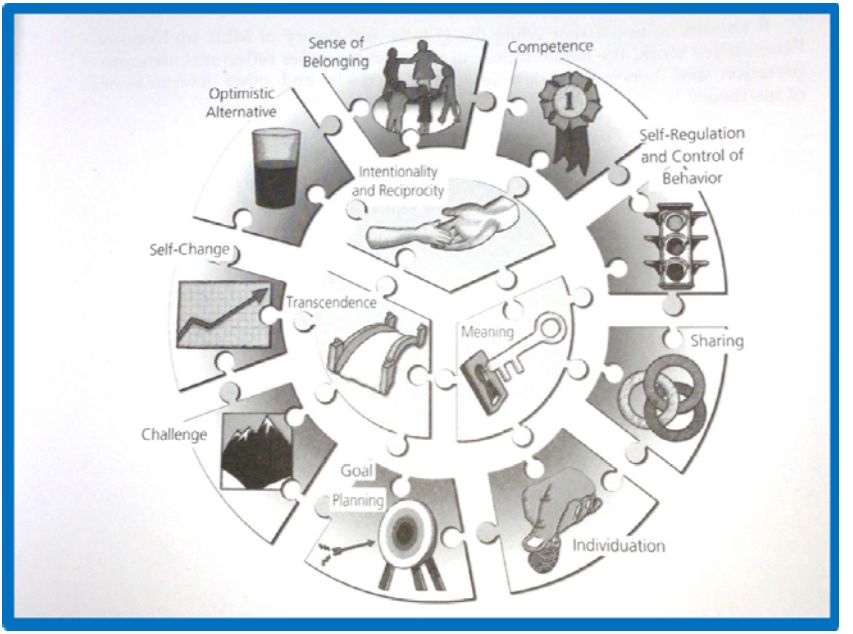


Figure 1. The mediation criteria (Mentis, M., Dunn-Bernstein, M. & Mentis, M., 2008)

Criticism

The principal criticism of Feuerstein's method lies in the insufficient scientific evidence about the effects on school performance (Bradley, 1983; Moseley et al., 2005), which makes very difficult to predict the transfer effects. The majority of criticism has focused precisely on this point (Campione & Brown, 1987; Bransford, DelClos, Vy, Burns & Hasselbring, 1987; Loarer, 1998; Loarer, Chartier, Huteau & Lautrey, 1995).

This research aims to contribute to the question of the transfer process and we are looking at how IE promote the academic success.

Romney and Samuels (2001) conducted a meta-analysis about the results obtained from controlled studies (in English) on the program before 2000. After the initial year of intervention, academic performance results showed some improvement, but many were modest and in some cases inconsistent.

The research shows that the process has the ability to improve more than the behaviour, but that are not transferred in the school environment. This result reinforces observations identified by other researchers. For example, Loarer, Chartier, Huteau and Lautrey (1995) have shared: "*Des effets [...] ont été obtenus sur certains test d'intelligence, mais pas ou tres peu sur les épreuves de personnalité, et il n'a pas non plus obtenu de transferts consistants aux résultats scolaires*" (p. 168).

This study merges the hypotheses of Jensen and Singer (1987) and Büchel (2007). According to Jensen and Singer transfer problems may be impacted by a lack of coordination between the school curriculum and the IE. The child's effective functioning requires both cognitive assistance and skills on which they can be applied. The acquisition process alone will not impact cognitive function, but if a student does not receive material on which he can enhance his learning efforts with IE, no progress is likely to be made.

According to Büchel, attempting to intervene with a learning issue can take a long time. However, any cognitive program must understand that educational institutions cannot easily provide 300 hours teaching to apply the program. The problem might be different if the program is applied as a preventive measure. The school should introduce metacognitive elements and include the concept of "teach how to learn" in a systematic way during the school year.

We believe that integrating these principles to the curriculum will help to overcome the dichotomy between "content-cognitive ability" and the transition from an instructive education to a formative education. Feuerstein's educational tools, such as the lesson plan, the cognitive map, the list of cognitive functions and criteria for mediation, in the hands of a mediator, can promote continuous analysis of a pupil's abilities and his potential. Then schools can conduct an analysis of the knowledge and skills acquired and track the transfer of cognitive skills to the areas of academic content.

Research study

Goals

The goal of this research study was to determine the Instrumental Enrichment's strengths and weaknesses in teaching pupils of the Primary School. In particular, we investigated the following aspects of learning:

- whether and to what extent Feuerstein's educational tools can be integrated into the school curriculum and significantly affect pupils' performance and the quality of teachers' learning mediation;
- the extent to which the quality of teachers' learning mediation affects academic performance.

Hypothesis

The assumption of this research is that Feuerstein's program does not positively influence academic performance if it is not integrated into the school curriculum.

It is thereby assumed that if the Feuerstein principles of mediated learning are applied to school activities, a *neuro-curriculum* can be built, resulting in a significant improvement in academic performance.

Vertical functions are specialized functions, are expressed in well-defined domains, are very sensitive to learning, change dramatically during the course of development, and are visible because they are associated with performance. In contrast, transversal functions are not specialized functions, are not domain-specific, change slowly, and are not visible because their role cannot be analysed separately from performance. Vertical cognitive functions are also called "skills", and can correlate with well-defined areas such as motor skills, language, graphic-expression skills, reading, writing, and arithmetic. Transversal functions are "invisible", but are essential to cognitive activity and are inextricably linked to the task. These functions include recognition, categorization, selection, planning, decision-making, representation, and control (Cornoldi, 1999).

The goal of this research study was to determine if application of Feuerstein's educational mediation principles and tools to the school curriculum facilitates the full integration of vertical and transversal cognitive functions,

thereby promoting school success and the student's full academic development.

Method

Participants

This research study involved four fourth grade classes in Primary School over the course of two school years (2013-2014 & 2014-2015). Specifically, 82 students, 4 teachers/mediator IE, and an IE mediator outside the school context were included.

Participant selection

The Authorized Feuerstein Centre from Sardinia provided a list of teachers trained in IE from the province of Sassari. From this list, we extrapolated teachers who worked with the third grade class. Then, six classes were selected where one teacher was trained on the Feuerstein method, but only five teachers agreed to participate in this study. Since we valued keeping homogeneity of school performance and quality of mediation by pre-test, one class was eliminated. Table 5 shows the tests results of the pre-test given in May 2013 regarding reading comprehension, listening comprehension, writing, numeracy, reasoning, prerequisite study skills, metacognitive study skills, and praxis skills.

Table 5.
Pre-test of basic and transversal skills

		N	Mean	Std. Deviation
Reading comprehension	Class group 1	19	8.32	1.701
	Class group 2	21	8.00	1.975
	Class group 3	16	7.56	2.476
	Class group 4	24	8.29	2.074
	Class group 5	18	8.61	1.501
Listening comprehension	Class group 1	19	8.89	1.595
	Class group 2	21	9.33	1.354
	Class group 3	16	9.13	1.586
	Class group 4	24	9.29	1.488
	Class group 5	19	9.53	1.577
Writing	Class group 1	19	1.63	.496
	Class group 2	21	1.52	.680
	Class group 3	16	*1.44	.512
	Class group 4	24	1.96	.690
	Class group e 5	18	*2.00	.333
Numeracy	Class group 1	18	17.50	2.834
	Class group 2	21	18.29	2.261
	Class group 3	16	17.38	3.423
	Class group 4	24	18.17	1.903
	Class group 5	18	19.11	1.491
Reasoning	Class group 1	18	20.28	4.322
	Class group 2	21	20.71	4.244
	Class group 3	18	22.44	4.693
	Class group 4	22	20.45	6.231
	Class group 5	18	21.89	2.988
Prerequisites study skills	Class group 1	19	8.42	2.411
	Class group 2	21	9.24	2.256
	Class group 3	16	*7.69	2.915
	Class group 4	24	9.08	2.302
	Class group 5	18	*10.22	2.074

Metacognitive study skills	Class group 1	19	3.84	1.068
	Class group 2	21	3.43	1.660
	Class group 3	16	3.06	1.289
	Class group 4	24	3.79	1.215
	Class group 5	18	3.56	1.199
		18	3.56	1.199
Praxis skills	Class group 1	19	8.00	2.544
	Class group 2	21	6.62	2.872
	Class group 3	16	7.11	3.445
	Class group 4	24	6.73	3.467
	Class group 5	18	7.33	2.086

The statistical analysis showed a significant difference between the Class group 3 and Class group 4 relative to the prerequisite study skills test (ANOVA: F (3,4)= 8.684, p = 0.21). For the writing and praxis tests, a non-parametric test was used for different independent samples, and the Kruskal-Wallis H test was used to determine the difference in independent samples drawn from the same population. The analyses revealed a significant difference in the writing test results between the groups tested (Kruskal-Wallis H Test: Chi-square = 14.685, df = 4, p = 0.005). The means reported in Table 1 show that Class group 5 reported the highest score. It repeated the text excluding this group from the origin school variable (Kruskal-Wallis H Test: Chi-square = 7.731, df = 3, p = 0.052). The results indicate that the Class groups 1, 2, 3, and 4 belong to the same population regarding the writing and praxis tests, even if the writing test was placed very close to the confidence level.

Table 6 shows the results of the metacognitive, motivational, and socio-emotional scores awarded by teachers in the observation grid.

Table 6.
Pre-test of metacognitive, motivational, and socio-emotional attitudes

	Class group 1		Class group 2		Class group 3		Class group 4		Class group 5	
	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation.	Mean	Std. deviation	Mean	Std. deviation.
Interp. relations.	10.37	1.422	9.86	2.393	8.94	2.711	9.40	1.555	9.45	1.276
Respect	9.63	2.338	8.76	2.965	8.50	2.956	9.00	1.803	8.35	2.390
Adaptability	9.53	1.349	9.95	1.884	9.33	2.544	9.76	1.091	9.95	.887
Participation	*9.32	2.358	8.76	2.791	8.44	3.148	8.00	2.217	*6.45	1.986
Responsibility	9.89	2.052	8.67	2.671	8.83	2.915	9.16	2.035	8.30	2.203
Engagement	9.63	2.499	9.43	2.271	8.22	3.209	9.16	1.930	8.95	1.877
Attention	9.42	2.589	8.90	2.625	8.67	3.029	8.40	2.533	8.15	2.059
Organization	9.68	2.689	9.10	2.488	8.17	3.294	8.96	2.245	8.30	1.867
Autonomy	9.00	2.749	8.95	2.312	8.67	2.787	8.76	1.393	7.35	1.496
Motivation	9.63	2.060	8.67	2.033	8.67	2.590	8.64	1.800	8.55	1.432
Control	*9.79	1.932	9.10	2.488	8.67	3.199	8.84	2.192	*7.10	1.071

For these variables, the Kruskal-Wallis H test was applied for different independent samples. The statistical analysis revealed a significant difference between Class groups 1 and 5 with respect to the participation variables (Kruskal-Wallis H test: Chi-square = 13,535, df = 4, p = 0.009) and control variables (Kruskal-Wallis H test: Chi-square = 16,068, df = 4, p = 0.003). Even in this case, we repeated the test excluding the group class 5 and we have verified that the class groups 1, 2, 3 and 4 belong to the same population with respect to the student's metacognitive, motivational and socio-emotional attitudes.

Given these results by ANOVA and the Kruskal-Wallis H test, we decided to exclude the Class group 5 from the study, and to include the remaining four classes. There were no significant differences, however, in the quality of teachers' learning mediation. The role attribution to groups, experimental or comparison, was not random. In fact, only two class groups accepted the treatment, and the remaining two assumed the role of comparison groups. The pairing between experimental and control groups, however, has been attributed to random distribution.

Procedure

This research study fits into the quasi-experiment typology. The factorial design provided four independent groups corresponding to four classes, two experimental and two comparison. The two experimental groups were subjected to two different types of treatment, as shown in Table 7. The two comparison groups followed the conventional curriculum.

Table 7.
Design factor between independent groups

GROUPS	TREATMENT 1	TREATMENT 2
EG 1: 24 students	3 hours of IE weekly substitute for 3 hours curriculum	Principles and tools of learning mediation integrated into 13 curricular activities in a year
EG 2 : 20 students		Principles and tools of learning mediation integrated into 13 curricular activities in a year
CG 3 : 20 students	Conventional curriculum	
CG 4 : 18 students	Conventional curriculum	

EG 1, submitted to the Instrumental Enrichment Program for a total of about 70 hours during the first year, worked with the following the first-level tools:

- Organization of dots
- Analytic perception
- Illustrations
- From Empathy to Action

The instruments were chosen in agreement with the classroom teachers, taking into account the annual program that the students need. In particular, teachers chose to strengthen some specific cognitive functions such as:

- Systematic exploration
- Need for precision, accuracy and completeness in data gathering
- Planning behaviour
- Inferential-hypothetical thinking
- Categorizing
- Adequate verbal tools

This program was administered by the author, who has served as a Feuerstein mediator since 2004. The classroom teachers, however, formed at the IE, and have applied the principles and tools of mediation of learning in 13 curricular activities during the first year. They were guided and supervised every 15 days. In particular, they were supported in the following tasks:

- Construction of educational units in accordance with the Cognitive Map principles;
- Lesson management according to the scheme developed by Feuerstein;
- Analysis of students' deficient cognitive functions;
- Application of the learning mediation criteria in the educational relationship.

The teachers were monitored through both classroom observations and video recordings. The four class groups involved in the research study were subjected to post-testing at the end of the first and second school years.

Table 8.
Assessment in interrupted time series

	Pre-test	**Treatment** (1° school year)	**Post-test**	**Treatment** (2° school year)	**Post-test**
EG 1	O1	X1	O2	X1	O3
EG 2	O1	X2	O2	X2	O3
CG 3	O1		O2		O3
CG 4	O1		O2		O3

Assessment tools

Three assessment tools were used:

1. Q1 VATA: an assessment battery by the MT GROUP (De Beni, Zamperlin, Friso, Molin, Poli e Vocetti, 2005), used to explore basic and cross skills, including reading comprehension, listening comprehension, writing, study skills, reasoning, numeracy, and praxic skills. It also includes an observation grid to assess metacognitive, motivational, and socio-emotional attitudes.
2. ASSESSMENT QUALITY OF LEARNING MEDIATION by Carol Lidz (Lidz, 1991) adapted to the group class. The Mediated Learning Experience (MLE) Assessment Scale by Carol Lidz is provides a tool to assess the mediation degree and quality that characterizes the interactions between a mediator and a child. It is used for children aged 2 to 5 years, but is potentially adaptable to a wider age range. It was developed to meet various needs:
    - to consider the multiple factors that occur within teaching and parenting relationships that can affect a child's cognitive development;
    - to monitor the progress and to evaluate the effectiveness of educational intervention;
    - to develop a profile of mediators' strengths and weaknesses.

This scale is intended to provide a behaviour assessment of mediators that may be relevant for a child's cognitive development.

Table 9.
Assessment quality of learning mediation

MEDIATION	SCORE				NOTE
Intentionality and reciprocity	0	1	2	3	
Mediation of meaning	0	1	2	3	
Mediation of transcendence	0	1	2	3	
Sharing child's experiences	0	1	2	3	
Sharing teacher's experiences	0	1	2	3	
Competence (regulation of the task)	0	1	2	3	
Competence (lode/encouragement)	0	1	2	3	
Competence (challenge)	0	1	2	3	
Psychological difference between child and mediator	0	1	2	3	
Psychological difference between subjects	0	1	2	3	
Answer to child's needs	0	1	2	3	
Emotional involvement	0	1	2	3	
Change	0	1	2	3	
Regulation and control of behaviour	0	1	2	3	

0 = no mediation; 1 = inconstant mediation; 2 = constant mediation
3= constant mediation with elaboration

3. FOCUS GROUP: this will be proposed at the end of the second year treatment, involving, at different times, the people directly and indirectly involved in research, such as students, teachers, and parents.

Results

Does Feuerstein's methodology, when integrated into the school curriculum, have a significant impact on students' academic performance and on the quality of teachers' learning mediation?

We used different statistical analyses for parametric variables and nonparametric variables: for parametric variables, the *t-test* was used and for nonparametric variables, the *Mann Whitney test* was used. The analysis was performed for all tests in order to verify if there were significant differences between experimental and control groups. The data analysis collected at the end of the first year is still in progress; therefore, we only have partial results at this time.

This study compared EG 1 that used two treatments, with CG 3 that used the conventional curriculum as parametric variables, including reading comprehension, listening comprehension, numeracy, reasoning, prerequisite study skills, metacognitive study skills, and study skill performance. There were no significant differences between the two groups (fig. 2).

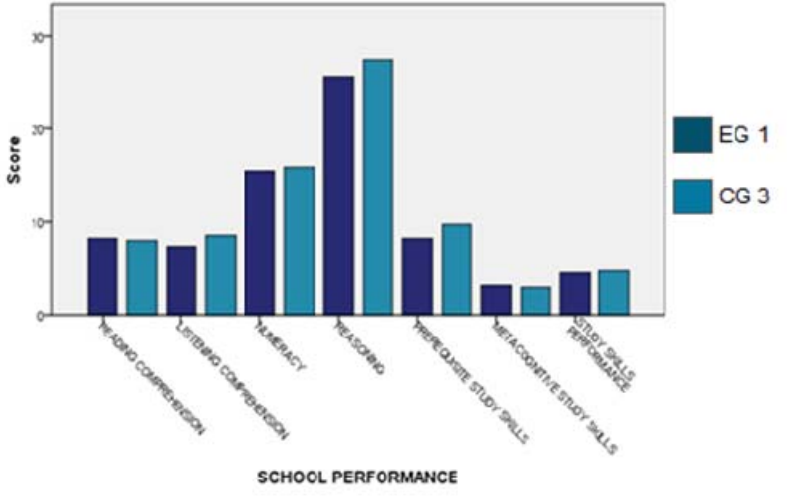


Figure 2. Comparison between EG1 and EG3

Similar results were obtained for EG 2 and CG4. There were no significant differences between the two groups (fig. 3).

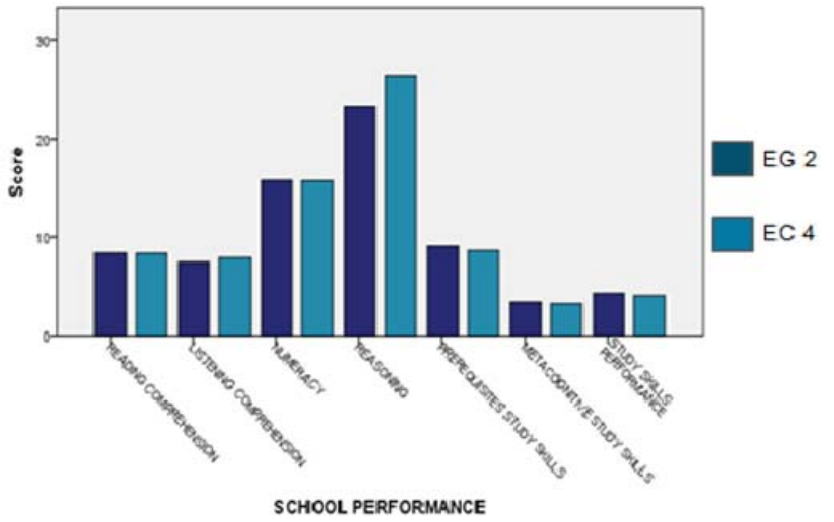


Figure 3. Comparison between EG2 and CG4

The most interesting result was the assessment of teachers' mediation quality. It compared teachers from EG 1 with teachers from CG 3. Teachers in EG 1 had the highest score in five mediations, whereas teachers in the control group had the highest score in only one mediation (fig. 4).

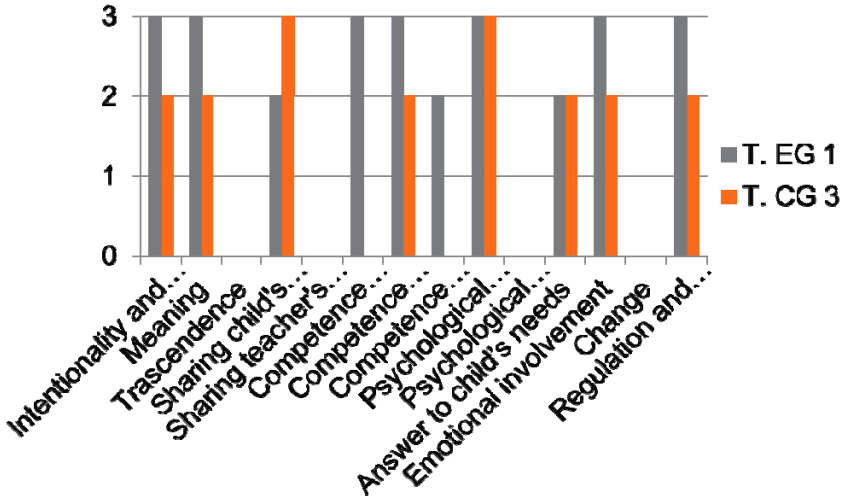


Figure 4. Quality of teachers' mediation

There were significant differences between teachers from EG 2 and from CG 4. Specifically, teachers in EG 2 had the highest score in more mediations (fig. 5).

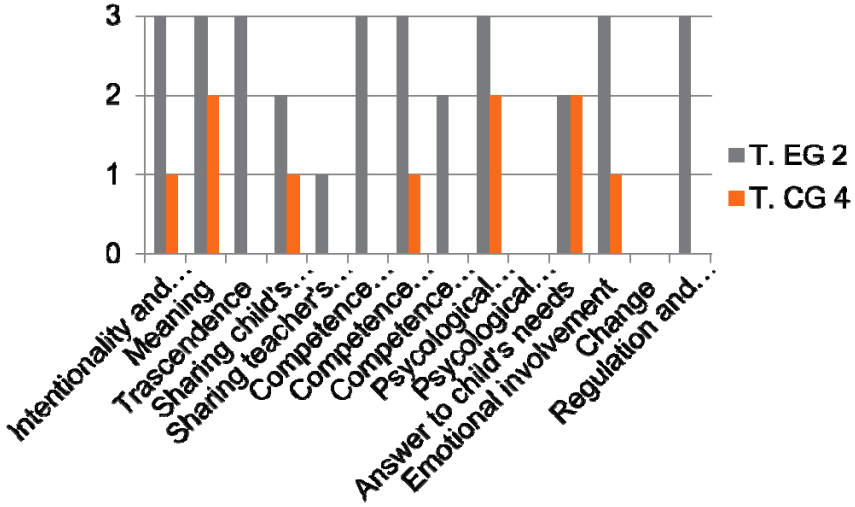


Figure 5. Quality of teachers' mediation

These results, although incomplete, showed that the quality of teachers' mediation improved in the two EG, but academic performance did not improve.

Conclusions

This research project aimed to integrate a cognitive education program; namely, the Feuerstein method, in the Primary School curriculum, and to measure the effects on students' learning and teaching quality. The main results that we expected to see were an improvement in students' school performance and in the quality of teachers' learning mediation.

The first statistical analysis conducted on the data collected in the first year did not show a significant difference in students' performance between the experimental and control groups. In contrast, we observed very interesting results regarding the quality of teachers' learning mediation. At the end of the first year, the teachers in the experimental group had higher scores than those in the control group in many mediations. This shows that it is necessary to potentiate the students' treatment.

Regardless of the results "*…cannot deny that the approach Feuerstein include declarations simple and understandable that allows the transfer of knowledge through concrete pedagogical acts*" (Büchel, 2007). Using the principles and tools of Feuerstein's method, we experienced the development of a *neuro-curriculum* in which students can "shop" while they learn, can monitor their improvement, and with the teacher's guidance, can automate effective cognitive paths.

The Feuerstein's theoretical and didactic proposal is placed in the complex society horizon. The educational tools born of his educational experience responding to the training needs of the information and knowledge society: *to teach how to learn*. We hope that the results of this and other research studies open the possibility of profoundly rethinking the curricula and teaching methods in all school grades.

References

Bradley, T.B. (1983). Remediation of cognitive deficits: A critical appraisal of the Feuerstein model. *Journal of mental deficiency research*, 27, 79-92.

Bransford, J.D., Delclos, V.R., Vye, N.J., Burns, M.S., & Hasselbring, T.D. (1987). State of the art and future directions. In C. Schneider-Lidz (Ed.), *Dynamic assessment* (pp.479-496). New York: Guilford.

Büchel, F. (2007). L'intervention cognitive en éducation spéciale. Deux programmes métacognitifs. *Carnets des sciences de l'éducation*, Genève: Université de Genève press.

Campione, J.C. & Brown, A.L. (1987). Linking dynamic assessment with school achievement. In C. Schneider-Lidz (Ed.), *Dynamic assessment* (pp. 82-115). New York: Guilford Press.

Cornoldi, C. (1999). *Le difficoltà di apprendimento a scuola*. Bologna: Ed. Il Mulino.

De Beni, R., Zamperlin, C., Friso, G., Molin, A., Poli, S., e Vocetti, C. (2005). *Q1 VATA. Batterie per la Valutazione delle Abilità Trasversali all'apprendimento*. Firenze: Giunti O.S.

Feuerstein, R., Rand, Y., & Rynders, J.E. (1988). *Don't accept me as I am. Helping "retarded" people to exel*. Boulder, CO: Perseus Publishing.

Feuerstein, R., Feuerstein, R.S., Falik, L., & Rand, Y. (2008). *Il Programma di Arricchimento Strumentale di Feuerstein*. Trento: Erikson.

Feuerstein, R., Rand, Y., & Rynders, J.E. (1995). *Non accettarmi come sono*. Milano: Sansoni Editore.

Jensen, M. & Singer, J. (1987). *Structural cognitive modifiability in low functioning adolescents: An evaluation of Instrumental Enrichment*. Report submitted to the State of Connecticut Department of Education, New Haven, Yale University

Lidtz, C. (1991). *Practitionner's Guide to Dynamic Assessment*. New York: Guilford Press.

Loarer, E. (1998). L'éducation cognitive: modèles et methods pour apprendre à penser. *Revue Française de Pédagogie*, 122, 121-161.

Loarer, E., Chartie, D., Huteau, M., & Lautrey, J. (1995). *Peut-on eduquer l'intelligence? L'evaluation d'une methode d'education cognitive*. Bern: Peter Lang.

Mentis, M., Dunn-Bernstein, M. & Mentis, M. (2008). *Mediated learning: Teaching, tasks, and tools to unlock cognitive potential*. Thousand Oaks, CA: Corwin Press.

Moseley, D., Baumfield, V., Elliot, J., Gregson, M., Higgins, S., Miller, J., et al. (2005). *Frameworks for Thinking*. Cambridge, UK: Cambridge University Press.

Piaget, J. (1965). *Il linguaggio e il pensiero del fanciullo*. Firenze: Giunti Barbera

Romney, D. & Samuels, M. (2001). A meta-analytic evaluation of Feuerstein's IE program. *Educational and Child Psychology*, 18 (4): 19-34

Vanini P., Il Metodo Feuerstein: come affrontare con successo le difficoltà di apprendimento. *Innovazione Educativa*, n. 6/1993.

Vanini, P. (1999). I concetti chiave dell' Educazione Cognitiva: la Mediazione. *Innovazione Educativa*, 6.

Vanini, P. (2003). *Potenziare la mente? Una scommessa possibile: l'apprendimento mediato secondo il Metodo Feuerstein*. Brescia: Vannini Editrice.

Vygotsky, L.S. (1986). *Thought and language*. Cambridge: MIT press.

What Reuven Feuerstein meant to me

NOAMI HADAS-LIDOR [1]

Reuven was like a father to me, a teacher, leader and true friend in my personal and professional development.

I was deeply affected by Feuerstein's' theories and through me his influence is carried on within my students, and through them on many consumers of mental health services and their family members. Feuerstein's' theories have affected us, and will continue on doing so. He instilled in us not just theory, but beliefs and a way of life. The core components of his theory are true love for all human beings and passionate faith in the ability of people to learn regardless of their age, disability and health status. Feuerstein was a pioneer in fighting for the rights of people with disabilities to live life fully with full integration into the community. He was sure in his belief in us, his pupils: Parents, teachers, therapists to be able to carry out the miracle, a miracle performed by human beings.

When I remember Reuven, I mostly recall small, moments, our first meeting and his promise to teach me everything he knew: "half of the universe" as he said then…And for many years I would travel once a week to Jerusalem to study with him, to hear him and watch him interact with children…parents…and always the feeling that won't take place, and then, like Moses, striking the stone and the water flowing freely out. I remember meeting in his office, with various professionals sitting around the table, from Israel and abroad, impressive people from different cultures, speaking different languages, and his concentration solely on the young boy before him, and together with this he was speaking with everyone in the room, in Hebrew, English, Spanish, French…switching from language to language.

And I remember how during an important meeting one young fellow entered to empty the dustbin, and Reuven stopped the meeting, turned to the young man inquiring how he was progressing and conveying interest in his

1. School of Occupational Health, Tel Aviv University. Address of correspondence: noami.h@gmail.com

family, his parents and relaying encouraging words. And all those in the room, watching quietly without interfering, just learning, and after hearing the young man's full reply turning his attention back to those present at the meeting.

I remember his trying to convince me to study a single individual for my PhD…in an effort to prove that cognitive therapy can change the individuals' brain and not just his behaviour, and I backed off out of fear. But he was right, as Eric Kandel, the Nobel Prize winner years later attested to.

I remember how glad I was to receive my PhD that proved that people with severe mental illness can develop and improve using Feuerstein's theories and methods.

And so many other meaningful moments…

So with deep sorrow and longing…and feelings of gratitude for the fortune of having Reuven in my life- I say goodbye.