The effectiveness of the metacognitive model with children in disadvantaged conditions.

Frolli A[1]*, Ricci MC[1], Rizzo S[1], Di Carmine F[1], Rega A[2], Savarese G[3], Franzese L[4]

[1]Disability Research Centre of University of International Studies in Rome, 00147, Rome, Italy

[2]Department of Psychology, University of Naples, 80133, Naples, Italy

[3]Department of Psychology, University of Salerno, 84084, Salerno, Italy

[4]Regional School Office, 80142, Naples, Italy

Abstract

Background: Educational Poverty (EP) is associated with socio-cultural and economic disadvantage mainly during the first years of life. Unfortunately, current education systems focus on knowledge transmission, neglecting the know-how and the motivation for learning; we hypothesize that increasing awareness on one's cognitive processes and actions allows optimizing both learning and the perception of academic success.

Methods: 88 subjects between the ages of 9 and 10 were recruited from eight schools in the province of Caserta and Naples and were randomly assigned to two groups, each of which received one of two different treatments: Structural Organizational (SO) model centered on resilience *vs.* Motivational Metacognitive Model (MM).

Results: Both interventions were effective in improving academic skills, but the MM intervention allowed a more significant improvements in the correctness parameter, both for reading and calculation skills, as well as for writing skills and in the perception of academic success.

Conclusion: Our study shows that a didactic intervention of a metacognitive type is effective within subjects living in a disadvantaged condition and contributes to increasing knowledge about educational poverty. Moreover, it could offer an example of intervention on school systems aimed at improving both teaching quality and educational plans.

Introduction

Educational poverty represents a complex phenomenon that brings together a new era of didactic and pedagogical interventions, overcoming the barriers of many conceptual superstructures and labels and opening the way to a real inclusion of the person. In a simplistic view, educational poverty could be exclusively associated with socio-cultural and economic disadvantage; however this conclusion is not exhaustive. In Italy, according to ISTAT data [1,2], almost 1.7 million families are estimated to be in absolute poverty (with an incidence of 6.4%), for a total of almost 4.6 million individuals (7.7%), who live in a condition of absolute poverty; but in fact, it is possible that in an economically disadvantaged territory there are excellent school facilities and services and it is equally possible that in a very low income family, a boy is devote to reading, art or any other form of cultural enrichment by developing skills and creativity [3]. Therefore, educational poverty does not only translate an income problem but a deeper disadvantage that has its roots in social, cultural and educational psychology problems that characterize the first years of a person's life. Specifically, educational poverty means the deprivation, for a child and/or a young person, of the actual opportunities to learn and experience, as well as the absence of a real stimulation to make their abilities, dreams, talents and aspirations flourish [4,5].

Each child should have the opportunity to develop his/her potential to the fullest; in other words, the child and/or teenager must not be precluded from learning, and to do so it is necessary to develop skills, creativity and problem solving. In the absence of a real education to learning, what is determined over time are fewer opportunities to grow from a learning and emotional/relational point of view [4,5]. All this can have short, medium and long-term effects on the psychological development of the person; in fact, children who are born in adverse conditions and who are denied adequate opportunities to learn and develop socio-emotional skills will be likely to present substantial difficulties in leading an autonomous and socially active life in the various stages of growth. In the first months and years of life, children are particularly vulnerable to environmental factors therefore educational hypo-stimulation can cause problems both in social and cognitive development: this effect is increasingly confirmed in modern neuroscience through neuroimaging studies (RM, fRMI, tractography, etc.) and epigenetics (science, which deals with the relationship between genes and the environment) [6-9]. Neurophysiological

studies conducted on children from families with different social status show, in fact, how socio-cultural deprivation is associated with alterations in some of the cognitive and linguistic prefrontal brain functions [7,10-12].

Luby et al. have shown, through the use of fMRI, how socio-cultural poverty affects the brain development of children, associating itself with lower dimensions of the hippocampus and amygdala, two regions of the limbic system that are fundamental for memory and emotional regulation. The DSM-5 [13,14]. Moreover, through the introduction of Neurodevelopment Disorders, has summarized the years of epigenetics research, which shows how an active stimulation of the child favors the development and enrichment of the synaptic network at the brain level.

Socio-cultural background in Italy

In Italy, there is a gap in human capital compared to most European countries: the average skills of students, measured through the international PISA-OECD tests, are lower than those of the OECD average [15,16]. Furthermore, significant differences were found between the regions of the South and the Center-North. Indeed, there is a significant correlation between regional gaps in skills developed during the school cycle and territorial development differences in socio-economic progress. In the southern regions, where the greatest number of economically disadvantaged children live, there would be the highest levels of educational poverty, especially in terms of participation and interest in educational and cultural activities. These conditions are accentuated by regional differences in the quality and quantity of other public services such as health, welfare, education. They not only represent an obstacle to the concrete realization of rights related to education, but also contribute to the intergenerational transmission of poverty and inequality, thus creating a vicious circle. However, in the South more than in the North, the school should make up for (as a privileged educational agency after the family) a series of unfavorable socio-economic variables concerning not only the territory of origin but also the intra-family environment.

These premises prompted us to evaluate the effectiveness of a metacognitive teaching model as a coping strategy in highly disadvantaged contexts. In this study we used two different teaching models to two groups of students attending the fifth grade and, after following them for a year, we compared the academic results in order to evaluate which of the two interventions could guarantee greater effectiveness in terms of learning and of perception of academic success. In particular, the hypothesis tested in work is a greater effectiveness of metacognitive teaching model compared to the structural/ organizational model.

Materials and Methods

Participants

The study included 88 subjects recruited from eight schools, four primary schools in the province of Naples and four primary schools in the province of Caserta, aged between 9 and 10 years (subjects were recruited at the beginning of the fifth elementary school and followed for one year until the end of the fifth elementary school). The inclusion criteria were: a) Normal cognitive functioning ($\geq 90°C$) assessed through the administration of Raven's Colored Matrices; b) Absence of Specific Learning Disabilities (SLD); c) Absence of other childhood neuropsychiatric disorders; d) Presence of intra-family socio-cultural disadvantage assessed by SES administration [17,18]. The data were collected in schools by licensed psychologists belonging to the DRC research center of the university of international studies of Rome-UNINT in collaboration with the USR (regional school office) of Campania, the university of Naples Federico II and university of Salerno.

Subsequently, the sample was divided into two groups, each of which pertaining to one of the eight schools recruited. The assignment to the groups was randomized. Each group consisted of 44 subjects overlapping by age, level of socio-cultural disadvantage, and aca-demic performance: Group 1 (Gr1) was composed of 44 subjects of mean age 9.73 (SD 0.34), SES level 1.53 (SD 0.43); Group 2 (Gr2) was composed of 44 subjects with mean age 9.84 (SD 0.42), SES level 1.49 (SD 0.37).

Instruments

The protocol used consisted of the following tests: Raven matrices and the Scale for the evaluation of the socio-economic level (SES) aimed at evaluating the inclusion in the sample [17,18]. Prove MT for the assessment of reading and comprehension skills, Tests AC-MT 6-11 for the assessment of calculation skills [19,20]. Battery for the assessment of writing and spelling competence-BVSCO aimed at evaluating writing skills and the multidimensional self-esteem test (TMA) for the evaluation of school self-efficacy [21,22].

Raven matrices (CPM-Colored Progressive Matrices): Raven's progressive matrices measure non-verbal intelligence throughout the entire range of intellectual development, from childhood to maturity, regardless of cultural level. They are used within children between the ages of 3 and 11. Our protocol included only matrices A and B, extracted from standard test, with an additional test (AB) of 12 elements. Each item requires completing a series of figures with the missing one, compared to a model presented, according to a criterion of increasing difficulty.

SES: Self-administered questionnaire that allows collecting information about the parents' educational and professional level and on the position of the person or family within the social system.

MT tests: Test battery used to evaluate correctness, speed of reading and comprehension of the written text, which are considered basic skills transversal to the different school disciplines, from the beginning of primary school up to the end of secondary school. For each single class, overall, there are 6 tests: 2 reading tests and 4 reading comprehension tests, designed to be administered into two different phases of the

school year (beginning and end). The reading test contains short texts to be read aloud that allow measuring the reading ability in terms of accuracy and speed. The text comprehension test evaluates the ability to understand the text. The child is requested both to read a text and to answer multiple choice questions related to the content of the text.

AC-MT tests: Test battery for evaluating numerical and calculation skills in children aged 6 to 11 years. It allows collecting information related to four different indices: two refer to the accuracy variable (but are collected through an individual and a collective phase). These two indices allow evaluating the accuracy of the answers. However, the test does not evaluate how automated such competence is. The third index (speediness) evaluates the calculation speed, or the also called total time/latency time.

BVSCO: Test that allows the evaluation of the child's skills in the three aspects of writing: Graphism, spelling competence and production of the written text. It is based on the spelling learning model, which provides that the child initially acquires the transformation mechanisms of the alphabetic phase and subsequently those relating to the spelling and lexical phase.

TMA: Questionnaire that allows a measurement of self-esteem with children and adolescents aged between 9 and 19. The TMA evaluates all six areas in which self-esteem is typically divided:

- Interpersonal area: How the subject evaluates his/her social relationships, with peers and with adults.
- School area: The successes or failures experienced in the classroom.
- Emotional area: Emotional life, the ability to manage negative emotions.
- Family area: Relationships in the family the degree to which they feel loved and valued, etc.
- Body area: Their appearance, physical and sporting abilities, etc.
- Area of mastery over the environment: The feeling of being able to dominate the events of one's life, etc.

Procedures

To tackle the problems linked to educational poverty, various intervention models have been designed; among these, two are mainly taken into consideration. The first model (the weakest), structural/organizational, essentially proposes an increase in resources, economic, educational and cultural, for the territory and families. Therefore, this model studies and fights the phenomenon exclusively from an economic and quantitative-organizational point of view. For example, at a territorial level, it aims to increase the provision of structures and/or services that have a potential educational and cultural value such as libraries, theater, sports organizations, and music academies; at family level, the provision of vouchers to purchase books, teaching or educational materials or the possibility of attending sports or recreational facilities free of charge.

This model of intervention acts directly on economic causes and consequently many negative effects such as early school leaving and failure to acquire skills do not always decrease. Furthermore, this type of intervention does not ensure lasting effects from an educational point of view. To strengthen this first model, a systemic perspective, centered on resilience, is often combined with this organizational/structural perspective. In this case, an enhancement of personal and/or community resilience is envisaged. Personal refers to the ability of children and/or adolescents to adapt to disadvantaged situations by successfully reacting to adverse circumstances, and managing to obtain good results despite the initial unfavorable situation; instead, community resilience refers to mutual compensation between social educational partners (family, school, recreational agencies, sports complexes) and pro-vides active balancing between the parties with the purpose to indirectly avoid negative consequences [23]. Resilience is closely linked to psycho educational variables such as the ability of children and adolescents to self-regulate in the learning, their well-being in the learning context and the network of their social relations with peers teachers and educators can successfully intervene on these variables [24].

The second model, more constructivists, motivational/metacognitive, aims to improve teaching strategies by favoring a teaching based on skills with a constant realization of knowledge and an active reflection on one's own cognitive processes and one's learning abilities. In this model, motivation is the fulcrum of the intervention and can increase through the concretization of knowledge. Furthermore, the educational system activates the adolescent by favoring a positive cascade, in which the subject will reflect more on his/her abilities in order to develop greater problem-solving skills. In this context, the educational figure supports motivation and the subject is an active user of knowledge from the very first learning experiences, working on his/her own skills and not exclusively on knowledge. As Cornoldi et al. points out, metacognitive knowledge refers to the ideas that an individual develops about his/her own mental functioning and includes impressions, intuitions, notions, feelings, self-perceptions [25]. On the basis of this knowledge (which does not refer only to cognitive processes), the subject is able to understand why things are for-gotten, how to learn, the effect of time on memory, etc.

In our work, the two models were taken into consideration and each was used specifically in one of the eight schools: the Gr1 was administered a preventive intervention based on the SO/RC model (Structural Organizational/Centered on Resilience), while the Gr2 was administered an intervention based on the MM (Motivational Metacognitive) model. In particular, the teachers of the eight schools were specifically instructed through a one-hundred-hour training. In the training for the SO/RC model, teachers learned teaching methodologies aimed at enhancing personal and community resilience together with strategies aimed at structural/organizational improvement of the educational network. In the training for the MM model, teachers learned metacognitive teaching methods aimed at increasing their sense of self-efficacy and problem-

solving skills as well as the awareness of their own learning processes.

The two trainings were carried out before the start of the fifth grade so that each school could benefit from the methodological/didactic application that had been assigned to it. Throughout the academic year, teachers had a monitoring and discussion meeting every 15 days on the school application of the reference model. The meetings were aimed at ensuring optimal application of the two models in the respective schools. We performed a first assessment at T0 (T0 before the beginning of the didactic intervention, at the beginning of the fifth grade) using the academic skills assessment protocol by administering the MT (entrance tests), AC-MT and BVSCO tests, and the assessment of academic success through the administration of the TMA, in order to have an initial assessment of the two groups and understand the starting level. At T1 (at the end of the fifth grade, after having performed the didactic intervention), the academic skills were re-evaluated (by administering the MT (final tests), AC-MT and BVSCO tests) and the academic success (by administering the TMA) of all subjects. Afterwards, differences between the two groups were analyzed [26].

Results

Data analyzes were performed using SPSS 26.0 statistical software. Significance was accepted at the 5% level ($\alpha < 0.05$). We used the T Test for independent samples, with two-tailed significance, to be able to make comparisons between the two groups at T0, for each test, and to verify if both groups were homogeneous before carrying out the didactic interventions. The results showed that the scores on the MT test were not significant in relation to the correctness parameter (t $(86)=-0.504$; p=0.616) in relation to the rapidity parameter (t $(86)=0.217$; p=0.829); in relation to the understanding parameter (t $(86)=-0.951$, p=0.344); to the AC-MT test for the correctness parameter (t $(86)=0.504$; p=0.615) for the rapidity parameter (t $(86)=-0.055$, p=0.956); at the BVSCO test (t $(86)=1.755$, p=0.083) and at the TMA test (t $(86)=-0.249$, p=0.804). These results indicate that the two groups at T0 (before the didactic interventions) were homogeneous (Table 1).

Test	Time	Group	Means	SD	t	p
MT_COR	T0	1	9.61	1.12		
	T0	2	9.75	1.39	-0.504	0.616
MT_RAP	T0	1	1.99	0.11		
	T0	2	1.99	0.09	0.217	0.829
MT_COM	T0	1	5.52	0.62		
	T0	2	5.65	0.71	-0.951	0.344
AC-MT_COR	T0	1	11.18	1.16		
	T0	2	11.04	1.36	0.504	0.615
AC-MT_RAP	T0	1	198.36	14.38		
	T0	2	198.52	12.51	-0.055	0.956
BVSCO	T0	1	11.59	1.22		
	T0	2	11.15	1.07	1.755	0.083
TMA	T0	1	36.81	2.53		
	T0	2	36.97	3.39	-0.249	0.804

Table 1. Comparison of the two groups at T0.

We then compared groups (1 and 2) at T0 and T1 to assess whether there were improvements after treatment (within-time variable) and then compared both groups at T1 (between group variable) to see which of the two didactic interventions were more effective. We therefore performed a mixed two-way 2*2 MANOVA (Multivariate Analysis of Variance): within-group factor=time (T0 and T1) and between-group factor=group (Group 1 and Group 2). We then analyzed the two independent variables (time and group) and the two dependent variables (Prove MT and Prove AC-MT). This analysis highlighted the following results:

As regards the MT tests, the following results were highlighted

Interaction scale*time*group is significant (F $(1.86)=126.238$, p<0.05). This data indicates that there is a significant interaction between the three subscales, time and type of treatment. More specifically, with both treatments there are significant improvements at T1 of the three MT test subscales, but in G2 there is a more significant improvement in the correctness parameter (Table 2).

Group	MT	Time	Mean	SD	F	p
1	COR	T0	9.61	1.12		
		T1	6.59	1.24		
	RAP	T0	1.99	0.11		
		T1	3.29	0.37		
	COM	T0	5.52	0.62		
		T1	7.45	0.63		
2	COR	T0	9.75	1.39		
		T1	3.5	0.95		
	RAP	T0	1.99	0.09		
		T1	3.88	0.24		
	COM	T0	5.65	0.71		
		T1	9.29	0.87	126.238	<0.05*

Table 2. Effect of scale * time * group interaction in MT tests.

As regards the AC-MT tests, the following results were highlighted: Interaction scale*time*group is significant (F (1.86)=83.700, p<0.05). This data indicates that there is a significant interaction between the two subscales, the time and the type of treatment. More specifically, with both treatments there are significant improvements at T1 of the two subscales in the AC-MT tests, but in G2 there is a more significant improvement in the correctness parameter (Table 3).

Group	AC-MT	Time	Mean	SD	F	p
1	COR	T0	11.18	1.16		
		T1	7.97	0.79		
	RAP	T0	198.36	14.38		
		T1	180.682	8.18		
2	COR	T0	11.04	1.36		
		T1	4.13	0.7		
	RAP	T0	198.523	12.51		
		T1	149.13	4	83.7	<0.05*

Table 3. Effect of scale*time*group interaction in AC-MT tests.

We then compared the Groups (1 and 2) at T0 and T1 by comparing the individual BVSCO and TMA tests to see which of the two didactic interventions was more effective (within-time variable) and then compared both groups at T1 (variable between group). We therefore performed a 2*2 mixed two-way univariate ANOVA: factor within groups=time (T0 and T1) and factor between groups=group (Group 1 and Group 2).

As regards the BVSCO test, the following results were highlighted

The factor within (time) is significant (F (1.86)=1481.789, p<0.05). This data indicates that there has been a change over time; therefore it is highlighted that both interventions were effective shown in Table 4.

T0		T1		F	p
Means	SD	Means	SD		
11.37	1.16	4.12	2.5	1481.789	<0.05*

Table 4. Effect of the within factor on the BVSCO test.

The between factor (group) is significant (F (1,86)=262.091, p<0.05). This data shows us that there is a difference between Group 1 and Group 2; therefore there is a significant difference between the two interventions, more specifically there is a greater efficacy with the MM intervention (Group 2) (Table 5).

Group 1		Group 2		F	p
Means	SD	Means	SD		
8.97	2.83	6.52	4.78	262.318	<0.05*

Table 5. Effect of between factors (group) on BVSCO test.

Time group interaction is significant (F (1.86)=115.341, p<0.05). This data indicates that there is a significant interaction between the time and the type of treatment. More specifically, both treatments showed efficacy, but this is even truer for the MM intervention is shown in Table 6.

Time	Group 1		Group 2		F	p	
	Means	**SD**	**Means**	**SD**			
T0	11.59	1.22	11.15	1.07			
T1	6.36	0.83	1.88	1.33	115.341	<0.05*	

Table 6. Effect of the time group interaction on the BVSCO test.

As regards the TMA test, the following results were highlighted: The within factor is significant (F (1.86)=2482.068, p<0.05). This data indicates that there has been a change over time; therefore it is highlighted that both treatments were effective in Table 7.

T0		T1		F	p
Means	SD	Means	SD		
36.89	2.98	58.37	6.16	2482.068	<0.05*

Tabel 7. Effect of within factor on TMA test.

The between factor (group) is significant (F (1.86)=126.189, p<0.05). This data shows us that there is a difference between Group 1 and Group 2; therefore there is a significant difference between the two treatments, more specifically there is a greater efficacy with the MM intervention (Group 2) (Table 8).

Group 1		Group 2		F	p
Means	SD	Means	SD		
44.93	8.73	50.34	13.69	126.189	<0.05*

Table 8. Effect of between factors (group) on TMA test.

Time*group interaction is significant (F (1.86)=148.311, p<0.05). This data indicates that there is a significant interaction between the time and the type of treatment. More specifically, both treatments showed efficacy, but this is even truer for the MM intervention (Table 9).

Time	Group 1		Group 2		F	p	
	Means	SD	Means	SD			
T0	36.81	2.53	36.97	3.39			
T1	53.04	3.37	63.7	2.71	148.311	<0.05*	

Table 9. Effect of the time*group interaction on the TMA test.

Discussion

Educational poverty as a complex social and educational psychology phenomenon involves various causal factors such as:

- The complexity of the current social fabric with economic and cultural discrepancies (lifestyles, habits, values, etc.) between the different classes.
- The incapacity of the school system to flexibly adapt to the needs of learners in the face of a change in cultural models and lifestyles.
- The lack of educational agencies unable to support current families in search of a new pedagogical dimension.
- The influence of the media and new technologies on school-age and adolescent subjects.

With regard to the school system, it was highlighted that school systems often respond inadequately to the needs of the new generations and are scarcely able to understand the need of a teaching based on skills. In fact, we often see a school that continues to deal with knowledge, neglecting the know-how and, above all, the ability to contextualize both knowledge and know-how. The core of a regenerated school should be the ability to arouse motivation and interest in learning by transforming the mere notional knowledge into skills, creativity and problem-solving strategies. In this regard, we decided to conduct this study with the aim of evaluating the effectiveness of the metacognitive teaching model as a coping strategy in highly disadvantaged contexts. Our outcomes showed an improvement in the academic abilities of reading, writing and calculating, highlighted by the significance of the scores in the MT tests and the AC-MT tests at T1. More specifically, it emerged that both interventions were effective in improving academic skills, but the MM intervention allowed a more significant improvement in the correctness parameter, both for reading and calculation skills, as well as for writing skills. Therefore, we can affirm that a didactic intervention of a metacognitive type is effective within subjects living in a disadvantaged condition, confirming our hypothesis that increasing awareness on one's cognitive processes and actions allows to optimize both learning and the perception of academic success.

Our study provides evidence that offering children tools that help them increase awareness of their cognitive processes and their actions, and that allow them to optimize learning and regulation of external responses (self-regulation, self-monitoring and metacognition) can be useful and successful for all those subjects living in disadvantaged conditions. Furthermore, our study also revealed an improvement in the children's perception of their school success, highlighted by the significance of the scores on the TMA test at T1. More specifically, both treatments showed to be effective. However, the perception of academic success experienced by children was more effective following the MM intervention as compared to the improvement of self-esteem skills.

In light of these results, it is necessary to monitor over time the various causal factors of educational poverty since nature is multifactorial, an expression of the interaction of social, economic and cultural variables. The lack of adequate tools to cope with educational poverty exposes children to the risk of exclusion from society, prevents healthy and adequate development and will have greater difficulties in the future in finding stable employment and living in adequate and dignified conditions, and therefore to find themselves in situations dependent on social assistance. Much remains to be done in terms of cultural possibilities and the quality of educational services offered to those in educational poverty [27-28].

Conclusion and Limits

Educational poverty often arises also from the poor ability of educational figures to strengthen secondary executive functions: the teacher should be able to favor the development of metacognition, as evidenced by our study. In other words, the school should have as its ultimate goal not the transmission of knowledge only, but the development of competence par excellence: I learn to learn. A modern and educationally rich school aims at achieving greater mastery of one's learning skills by increasing the subject's motivation and creativity. Our results have shown how the MM model allows to obtain effective results in subjects placed in disadvantaged situations, however we specify that an organizational model based on resilience cannot be ignored, so we believe that the two models (SO/RC and MM), integrated with each other, could guarantee greater overall effectiveness. We hope that future studies may thus integrate both treatments and count on a larger sample since it constitutes a limitation of our study. However, overall, the results of this study contribute to increasing knowledge about educational poverty and could offer an intervention on school systems aimed at improving both teaching quality and educational plans, allowing thus the activation of recovery paths in an important early evolutionary phase.

Limit of the study is represented by the small number of the sample and the lack of follow-up that would allow a long-term evaluation of the knowledge and skills acquired, not only in the short term but also in the medium and long term, and a possible generalization achieved results. Moreover, the acceptance of learning to learn should also be improved through the acquisition of the prospect of hope. The motivation to know arises from a perspective of hope that learning can improve one's existence. Hautamaki et al. and Kupiainen et al. stated that the main pedagogical objectives are two: learning to learn skills and motivation for learning, *i.e.* the adaptive and voluntary mastery of the learning action (learning to learn). Learning to learn therefore includes a cognitive perspective (thinking skills, prerequisites and/or gaps) but also a socio-affective or hopeful perspective (trust in one's ability to learn, which guides the use of these skills).

Author Contributions

Data Availability Statement

The data is available from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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*Correspondence to:

Frolli Alessandro

Disability Research Centre of University of International Studies in Rome

Rome

Italy

Tel: 3474910178

E-mail: alessandro.frolli@unint.eu