Intervention for peer mediation and mother-child interaction: The effects on children's mediated learning strategies and cognitive modifiability

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\section*{Abstract}

The effects of intervention for peer mediation and mother-child mediated learning experience (MLE) strategies on children's MLE strategies and cognitive modifiability (CM) was investigated on a sample of 100 mother–child dyads. CM was examined in domains of executive functions and analogical reasoning. The MLE interactions were analyzed by Observation for Mediated Interaction (OMI) scale. Children of high- and low-mediating mothers were assigned to experimental (\(n = 49\)) and control (\(n = 51\)) conditions. The experimental group received a peer-mediation program and the control groups received an alternative creativity program. The children (in Grade 3) were assigned as mediators of learners (in Grade 1) and taught them analogical reasoning problems. The peer interaction was videotaped and analyzed by the OMI. All children were given dynamic assessment after the interaction. Children in the experimental group showed higher MLE strategies and CM than did children in the control condition. Mediators of low-MLE mothers in the experimental group showed greater CM than did mediators in the control group. Structural equation modeling analysis showed that mediators' cognitive modifiability was explained by proximal factors of treatment, mothers' quality of mediation (QM) and mediators' QM; learners' cognitive modifiability was explained by mediators' QM. The findings were discussed in relation to the MLE theory and earlier findings.

\section*{1. Introduction}

An important question asked frequently by researchers and clinician is whether participation in a cognitive education program aimed at developing mediated learning experience strategies (MLE, Feuerstein, Feuerstein, Falik, & Rand, 2002) compensates for low quality of mother-child interaction as regard the effects on development of children's MLE strategies, and cognitive modifiability (CM) in domains of executive functions and cognitive skills. In the current study we try to deal with this question by applying a relatively novel cognitive education program: The Peer Mediation with Young Children (PMYC, e.g., Shamir & Tzuriel, 2004; Tzuriel & Shamir, 2010). The main outcome variables were children's MLE strategies, as observed in peer interactions and their 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 et al., 2002; Tzuriel, 2001, 2013). Our research is guided mainly by Feuerstein's theory of MLE (Feuerstein et al., 2002; Tzuriel, 1999, 2001, 2013) and Vygotsky's socio-cultural theory of mental development (e.g., Rogoff, 1990, 1994, 1999; Tudge, 1996; Valsiner, 1988; Vygotsky, 1962, 1978, 1981; Wertsch, 1985). In the following sections we introduce briefly (a) Feuerstein's MLE theory, (b) the Peer Mediation with Young Children (PMYC) Program and specifically on its effects on children's MLE strategies and CM, and (c) the effects of parent-child MLE interaction on children's CM.

\subsection*{1.1. Feuerstein's mediated learning experience (MLE) theory}

According to the MLE theory parents are conceived of as active-modifying agents in directing and shaping their children's development. MLE interactions are defined as a process in which parents or substitute adults interpose themselves between a set of stimuli and the human organism and modify the stimuli for developing children. In mediating the world of stimuli, parents may use different strategies such as focusing, alerting attention, changing the...
stimulus frequency, order, and intensity, relating new information to familiar contexts, and regulating the order and timing of new information. Good mediators relate also to children's motivational aspects by arousing their attention, curiosity, and vigilance, focusing on relevant aspects of the situation, and providing meaning to neutral stimuli. From a cognitive perspective, adequate mediation facilitates development of cognitive functions required for temporal, spatial, and cause-effect relations. Children gradually internalize the MLE processes, which become integrated mechanisms of change in the future. As children develop internalized self-mediation strategies, their parents gradually withdraw from the situation and allow the children more autonomy in implementing the acquired mediated strategies. Adequate MLE interactions facilitate the development of various cognitive functions, learning sets, mental operations, strategies, reflective thinking, and need systems. The acquired and internalized MLE processes allow developing children later to use them independently, to benefit from novel learning experiences in varied contexts, and to modify their own cognitive systems. Mediation 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 (Tzuriel, 2013).

Lack of or inadequate MLE may be derived from two broad categories: (a) lack of environmental opportunities for mediation, and (b) inability of the children to benefit from mediational interactions that are potentially available. In the first case, lack of or inadequate mediation derives from parents' low educational level, traumatic life events, lack of parents' awareness of 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 mental disabilities that act as barriers to register mediation that may be offered to them. Feuerstein et al. (2002) suggested 12 strategies of MLE, but only the first five have been operationalized in studies of infants and young children (Klein, 1988; Klein, Weider, & Greenspan, 1987; Lidz, 1991; Tzuriel, 1996, 1999, 2001, 2013; Tzuriel & Eran, 1990; Tzuriel & Ernst, 1990; Tzuriel & Weiss, 1998) and in studies on peer mediation (Shamir & Tzuriel, 2004; Tzuriel & Shamir, 2007, 2010) and siblings (Klein, Zarur, & Feldman, 2003; Tzuriel & Hanuka-Levy, 2014).

According to Feuerstein and colleagues, an adult-child interaction can be defined as mediated interaction if it contains three basic “ingredients”: Intentionality and reciprocity, meaning, and transcendence. These criteria are considered to be necessary for an interaction to be classified as MLE. Other criteria can contribute to cognitive development but are not regarded as necessary and/or sufficient in a mediated interaction.

(a) Intentionality and Reciprocity is an interaction characterized by efforts to create in the child a state of vigilance, and to facilitate an efficient registration of the information (input phase), an adequate processing (elaboration phase), and accurate responding (output phase). The reciprocity component is of crucial importance to the quality and continuation of the mediation process; when mediated children respond to mediators' behavior, it enables mediators to adjust their mediation and continue the process efficiently. A parent can draw a child's attention to a specific aspect of a drawing, highlighting its specific features, and sensitively waiting and even encouraging the child's response.

(b) Mediation of Meaning refers to interactions in which the mediator tries, when presenting an object, to emphasize its significance and worth. This is done by expressing affect and interest and by pointing to its importance and value. The significance of a stimulus can be conveyed nonverbally (e.g., facial expression, tone of voice, rituals, repetitious actions) or verbally (e.g., illuminating a current event, activity, or learned context, relating it to past or current events, and explaining its value). Mediation for meaning may be expressed by enthusiasm in the presence of an event and/or explaining the personal significance and unique importance of a stimulus that the child might look neutral.

(c) Mediation for Transcendence (expanding) is characterized by going beyond the concrete context or the immediate needs of the child. The mediator usually tries to reach for general principles and/or goals that are not bound to the “here and now” or the specific and concrete aspects of the situation. Mothers, for example, might go beyond the children's concrete experience and teach strategies, rules, and principles in order to generalize to other situations. Mediation of transcendence occurs either in spontaneous family contexts (e.g., eating, bathing) or structured contexts. In both situations, parents use the interaction to mediate important generalized principles, rules, values, and concepts. It should be noted that although mediation for transcendence depends on the first two criteria, the combination of all criteria becomes a powerful vehicle for the development of cognitive modifiability and the widening of the individual's need system.

(d) In Mediation of Feelings of Competence, mediators initially arrange the environment to ensure the children's success and interpret the environment in a manner that conveys to the children the awareness of the capability of functioning independently and successfully. This is done in various ways, such as reorganizing the children's environment so as to ensure opportunities for success, explaining the reasons for successes and failures, and by rewarding the children for attempts to master the situation and cope effectively with current problems. Mediators provide feedback not only for successful solutions but also for partially successful performances and for attempts at mastery.

(e) In Mediation for Self-Regulation of Behavior the mediators regulate children's responses, depending on the task demands, as well as on the children's behavioral styles. Regulation of behavior is carried out by either inhibiting impulsive tendencies or by accelerating inefficient slow behavior. This mediation is of critical importance in helping children register information accurately, delay immediate gratification, and pace the inner rhythm of response as a function of task demands. Mediation of regulation of behavior affects the whole process of mental activity in input, elaboration, and output phases of the mental act. It can be carried out by analyzing the task components, inhibiting acting-out behavior, delaying immediate gratification, focusing on task characteristics, and eliciting metacognitive strategies.

According to Feuerstein, the MLE strategies used in parent-child interactions help children internalize learning mechanisms, facilitate learning processes and self-mediation, give indications about future changes of cognitive structures, develop deficient cognitive functions, and provide for the ability to benefit in the future from mediation in other contexts. For example, a child who receives adequate mediation for Transcendence (i.e., expanding information to teach rules and strategies) internalizes this specific type of mediation and will tend to apply it efficiently in other contexts. The efficient use is not limited only to provision of mediation by others but also to generation of transcendence when confronted with new situations. Children will transfer the rules and strategies learned previously to other problems that vary in terms of content domain, levels of complexity, novelty, and abstraction. In the same way, children who experience adequate mediation of meaning
internalize this interaction and tend to use it later in various contexts. They will be not only more open to mediation of meaning but also will initiate attachment of meaning to new information rather than passively waiting for meaning to appear.

1.2. Level I and level II of proximal factors

In Feuerstein's terms the effects of the cognitive mediational program and the mothers' quality of mediation are considered as proximal factors that explain directly the children's cognitive modifiability. Feuerstein, however, did not specifically refer to the effects of children's own experience of mediation on others on their own cognitive modifiability. In the current study we proposed a synthesis of a constructivist approach with the MLE theory as regards a distinction between two levels (I and II) of proximal factors. The causal model is presented in Fig. 1. Based on the constructivists' theory (e.g., Brownstein, 2001; Rhodes & Bellamy, 1999) we assume that an actual activity in a mediation process such as peer-mediation is considered to be a more powerful factor for internalizing mediation strategies than is being exposed to mediation from a mediating agent (e.g., parent, teacher). That of course depends on the duration and the intensity of each type of interaction. Based on earlier studies on peer-mediation we posed a question whether a relatively short-term intervention for peer-mediation serves as a potent proximal factor (level II) in enhancing children's cognitive modifiability beyond the effect of mother-child MLE (level I).

1.3. The peer mediation with young children (PMYC) program

The PMYC (e.g., Shamir & Tzuriel, 2004) is a relatively novel approach based on the sociocultural theory of Vygotsky (1962, 1978, 1981) and the mediated learning experience (MLE) theory of Feuerstein (e.g., Feuerstein et al., 2002). In some ways the PMYC is similar to the Peer Assisted Learning (PAL) approach (Brown, Metz, & Campione, 1996; Crook, 1998; Griffin & Griffin, 1997; Rogoff, 1990, 1994, 2003; Topping, Dekhinet, Blanch, Corelles, & Duran, 2013; Tudge, 1996; Webb, 2009); both are focused on strategies for enhancing children's learning processes, for taking personal responsibility and control for their own acquisition of knowledge and skills and for constructing meaningful solutions to problems. The effectiveness of PAL has been demonstrated with respect to children's academic achievement (e.g., Fuchs & Fuchs, 2005; Griffin & Griffin, 1997; O'Donnell & King, 1999; Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003; Topping, 2001), attitudes toward learning (e.g., King, 1997), and social and behavioral skills (e.g., Kamps, Barbeta, Leonard, & Delquadri, 1994; McAuliffe & Dembo, 1994). Piaget (1967) has already argued that cognitive development is viewed in part as an outcome of peer interaction that enhances different cognitive perspectives, and leads, consequently, to socio-cognitive conflict. Such conflict motivates each participant in the interaction to elaborate on his or her thinking processes, to justify a position, and to present a convincing response. These processes require construction of new schemas and novel thought patterns. Vygotsky added, significantly, that the interaction with a more cognitively competent partner, whether child or adult, is more effective than interaction with a same-level partner. Vygotsky's followers (e.g., Rogoff, 1990; Tudge, 1996) have argued that cognitive development takes place when learners, displaying different levels of cognitive attributes, cooperate to complete a given task. A peer-cooperation process, moreover, helps the learners construct shared understanding.

The PMYC is unique with regard to four aspects: (a) It is based on a comprehensive theoretical model integrating cognitive and emotional components and reflects MLE principles that promote "learning how to learn" among young children. (b) It is beyond content domains or contexts of learning and can be applied to a variety of problem-solving tasks. (c) The peer-mediation strategies are structured, but allow considerable room for flexibility and creativity. (d) The status of the learner and that of the mediator are distinguished; that is, the mediator is perceived as more competent than the learner on the basis of both age and experience.

The objectives of the PMYC program are to enhance (a) a mediational teaching style, (b) learning skills and cognitive modifiability, (c) learning skills of learners mediated by their peers, and (d) learning-to-learn and school performance among mediators. The PMYC includes learning of the basic ideas and MLE strategies, adapted to the children's age level (Shamir & Tzuriel, 2004). The mediators learn that these principles will assist them in helping their peers as well as themselves in solving problems and independent learning in different contexts. The program includes basic conditions for effective peer interaction, such as respecting the learner, showing empathy, and providing "personal space" for activity.

The PMYC program is characterized by three operational components: (a) teaching of the basic MLE principles adapted for young children in terms of level of terminology and strategies, (b) observing and discussing a didactic film introducing the MLE principles, and (c) practicing the MLE principles with peers by using multimedia programs and conventional materials. A didactic videotape is aimed at enhancing internalization of each mediation principle. The program also includes learning aids such as computer programs, games, and stickers with visual symbols of the principles, verbal slogans, and work sheets. Each mediation principle is assigned a visual symbol, a name, and a verbal slogan. For example, mediation for feelings of competence is represented by the visual symbol of a "smiley" face, the symbol's name is "Smiley" and the verbal slogan is "Tell me 'good for you' in everything I do cor-
nymically captured the interest of researchers for several decades (e.g., Mattanah, Pratt, Cowan, & Cowan, 2005; Stright, Herr, & Neitzel, 2009; Wood, 1989), responsiveness (e.g., Bornstein & Tamis-LeMonda, 1990), and MLE (Feuerstein et al., 2002; Klein et al., 1987; Tzuriel, 1999, 2001, 2011a, 2011b, 2013). Some researchers have focused on the concept of attachment in early years as a predictor of cognitive development in childhood (e.g., Mikulincer, Shaver, & Pere, 2003; Moss & St-Laurent, 2001; Sroufe, 1988; West, Mathews, & Kerns, 2013). Research findings show clearly that specific activities of parents relate to their children’s cognitive development and that both the child and the parents influence the child’s intellectual development (i.e., Berk & Spuhl, 1995; Borstein, 1985, 1989a, 1989b; Borstein, Azuma, Tamis-LeMonda, & Ogino, 1990; Cristofaro & Tamis-LeMonda, 2012; Klein, 1988, 1991, 1996; Klein & Alony, 1993; Korat, Ron, & Klein, 2008; Rodriguez et al., 2009; Tzuriel, 1999, 2001, 2013).

Several studies were designed primarily to investigate the relative effects of distal factors (e.g., socioeconomic status, parental emotional rejection) and proximal factors (MLE) in the determination of the child’s cognitive modifiability as well as studying context and subjects’ characteristics in determining the adequacy of MLE strategies in the family and among peers (e.g., Trabelsi et al., 2015; Tzuriel & Shamir, 2010) and teachers (e.g., Tzuriel, Kaniel, Zeliger, Friedman, & Haywood, 1998). The general hypothesis in all these studies was that MLE interactions as representing learning processes within the family are more accurate in predicting the DA post-teaching performance than outcome static measures or DA pre-teaching measures. The rationale behind this hypothesis is that adequate MLE offers children increased “psychological tools” that serve to expand and differentiate their zone of proximal development (ZPD). This is why the upper level of ZPD measures would be more accurate as a predicted outcome of MLE interactions than static test performance (Tzuriel, 2001).

A major finding repeated in almost all studies was that children’s post-teaching scores (or gain scores) on DA measures were better predicted by MLE mother-child interactions than were static test scores (or pre-teaching DA scores). For example, in a study on kindergarten kibbutz children (n = 47) they were administrated Raven’s Coloured Progressive Matrices (CPM, Raven, 1956) and a DA measure for young children: 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. The pre-teaching (static measure) was predicted only by the CPM (R = 0.40, p < 0.004), the post-teaching was predicted by both MLE–Total and CPM (R = 0.69, p < 0.002), and the gain was predicted only by MLE–Total score (R = 0.43, p < 0.001). This intriguing predictability pattern found across the three regression analyses indicates that the more the criterion score was saturated with teaching effects, within the testing DA procedure, the greater was the variance contributed by MLE mother–child processes.

A structural equation model (SEM) analysis was applied in a series of six studies in which distal factors (e.g., socioeconomic level, severity of ADHD), and proximal factors (i.e., MLE strategies) of cognitive modifiability were compared (e.g., Tzuriel & Ernst, 1990; Tzuriel & Weiss, 1998). In all of these studies mother–child interactions were observed during free-play and/or structured (teaching) situations using the Observation of Mediation Interaction (Klein et al., 1987). One of the major findings 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 such as pre-teaching DA scores or Raven’s Standard Progressive Matrices (Raven, 1956). Examination of the differential prediction pattern of cognitive modifiability by specific MLE strategies showed that (a) MLE criteria were predicted by the distal factors of mothers’ SES, acceptance/rejection and children’s personality orientation, (b) the distal factors did not explain directly the children’s cognitive modifiability, (c) the most striking finding emerging from all six studies is that the MLE strategy that has appeared as most powerfully associated with cognitive modifiability is mediation for transcendence (i.e., expanding principles beyond the immediate context, beyond the “here and now”).

1.5. Questions, objectives and expectations of the study

1.5.1. Major questions of the study

(a) To what degree the PMYC program can compensate for lack of or deficient MLE strategies in families and consequently enhances development of children’s MLE strategies and cognitive modifiability. On the basis of previous peer-mediation studies (e.g., Shamir & Tzuriel, 2004; Tzuriel & Shamir, 2007, 2010), we expected the PMYC program to be effective with all children but especially with children whose mothers demonstrate a low level of use of MLE strategies.

(b) To what degree does the PMYC program facilitate process-oriented cognitive behaviors as compared with outcome-oriented scores? Because the PMYC program is focused on mediation processes, one would expect to see the direct effects on process oriented measures of cognition to be more powerful than on outcome-oriented measures. On the basis of previous findings, we assumed that the practice of peer mediation following the PMYC training would support the mediators’ “learning-to-learn” skills as observed in process oriented measures of planning and self-regulation and outcome measure of analogical reasoning. Subsequent changes in the mediators’ cognitive outcome would reveal how well the mediators had improved their own self-regulated learning in response to the mediation experience.

In the present study we used two tests before and after the PMYC program. Before the PMYC (Time A) the tests were administered in a standardized way, whereas after the PMYC the tests were administered in a DA format, which included pre-teaching (Time B), and post-teaching (Time C) phases (see Fig. 2). In-between
the pre- and post-teaching phase each child was taught individually for about 45 min the principles of solving problems. The pre-to post-teaching improvement was taken as indication for cognitive modifiability. It should be noted that the mothers of the mediators were also observed interacting with their children and that the learners were tested before and after being taught by their peer mediators.

The process-oriented measure was the Seria-Think Instrument (Tzuriel, 2000a), which assesses executive functions of planning behavior and self-regulation (control of impulsivity). The outcome-oriented measure was the Analogies subtest from the Cognitive Modifiability Battery (e.g., Tzuriel, 1995, 2000b; Tzuriel & Shamir, 2010). A group of children in Grade 3 were assigned to the experimental group who received the PMYC program. They were compared with children in a control group who received an alternative program. Children in both groups were asked to teach problems from the Children's Inferential Thinking Modifiability (CITM, Tzuriel, 1989) test to younger peers in Grade 1. The interaction was videotaped and analyzed later by the OMI scale. At the end of the intervention children in both groups were given the process-oriented and outcome-oriented measures in a DA format (see design in Fig. 2).

1.5.2. Objectives of the study

(a) To study to what degree the PMYC program enhances MLE strategies of children when interacting with their peers.

(b) To study the interaction effect of mothers-child MLE strategies and PMYC program on children’s MLE strategies.

(c) To study the interaction effects of mother-child MLE strategies and PMYC program on children’s cognitive modifiability.

(d) To study the relative effects of level I (mothers’ quality of mediation) and level II (mediators’ quality of mediation) as proximal factors on cognitive modifiability of mediators.

1.5.3. Expectations

1. Mediators who participate in the PMYC program (experimental group) will display a higher level of MLE strategies when observed teaching their peers than will mediators in the control group who did not participate in the program. It should be noted that although the effects of the PMYC on MLE strategies has been demonstrated and validated in earlier studies (e.g., Shamir & Tzuriel, 2007; Tzuriel & Shamir, 2010), we intended to replicate this finding.

2. Learners in the experimental group will show higher responsiveness to mediation than will learners in the control group. Because the PMYC program was expected to affect the mediation level of mediators we expected that consequently the responsiveness of the learners will be also higher in the experimental than in the control group. In other words, the learners’ responsiveness indicates another facet of the effectiveness of peer mediation.

3. Higher correlations between mothers’ and their children’s MLE strategies will be found in the experimental than in the control group. Equal correlations in the experimental and control groups would indicate that MLE strategies are transmitted from parents to children spontaneously without any need for further intervention with the children. On the other hand, higher correlations in the experimental than in the control group would indicate that the intervention enhances the trans-generational transmission of mediation patterns.

4. Mediators in the experimental group will show more pre- to post-intervention improvement on the process-oriented measures as tapped in the Seria-Think Instrument (Tzuriel, 2000a) and on the outcome-oriented measure as tapped in the CMB Analogies subtest (Tzuriel, 1995), than will mediators in the control group.

5. Children of mothers with low use of MLE strategies in the experimental group will show higher cognitive modifiability than will comparable children in the control group. We expected the PMYC program, given to the experimental group, to be a compensating factor enhancing cognitive modifiability.

6. Mediators’ cognitive modifiability will be explained by all proximal factors of treatment, mothers’ quality of mediation (QM) and mediators’ QM. The causal paths of influence for mediators are presented in Fig. 1. On the basis of the distinction between levels I and II of the proximal factors we expected that the level II of mediators’ QM will be more robust in explaining the mediators’ cognitive modifiability than the level I factors of mothers’ QM and treatment (see Fig. 1 mediators).

7. Learners’ cognitive modifiability will be explained directly by mediators’ QM; whereas the mediators’ QM will be explained by the proximal factors of treatment and mothers’ QM (see Fig. 1-learners).

1.5.4. Specific questions of the study

The questions are of an exploratory nature since no previous theory or research has been found to support a clear expectation.

1. Will mothers show greater use of MLE strategies than their children do in the children’s role as mediators in the peer’s interactions? In general, we assume that mothers show higher level of MLE strategies than their children in their role as mediators in the peer interaction; however, the differences between mothers and their children will be greater in the control condition than in the experimental condition (participation in the PMYC program).

2. Which factor will predict better the children’s quality of mediation, mothers’ quality of mediation or participation in the PMYC program? The answer to this question would carry applicative meanings for development of intervention programs that may compensate for lack of mediation within the family.

2. Method

2.1. Participants

The sample was composed of 100 mother-child pairs and 100 pairs of mediator-learner children; mediators came from the third grade and learners from the first grade. Each child in the mother-child pair was assigned later as mediator, in a peer-mediation condition to a young learner.

2.1.1. Children’s sample

The sample (100 pairs of mediators/learners) was drawn from schools located in a central region in Israel. The mediators were randomly drawn from 14 classes in the 3rd grade, and the learners were randomly drawn from 12 classes in the 1st grade. The mediator-learner dyads came from the same school. The mediators were assigned to one of four subgroups (using a $2 \times 2$ design) based on mother-child quality of mediation (low versus high) and treatment (experimental versus control). In order to assign the children to high- versus low-level of mother-child MLE, the interaction of each mother-child pair was videotaped and analyzed for frequency of MLE strategies using the OMI (see Measures and Procedure). Based on the median score (Med. = 62) of the overall mother’s Quality of Mediation Index (see Results), children were assigned first to two groups: children of mothers with a high level of mediation ($n = 51$) and children of mothers with a low level of mediation ($n = 49$). Half of the mediators were assigned to an experimental group who participated in the PMYC program and
the other half received an alternative program. Since gender effects were found to affect the quality of interaction (e.g., King, Staffieri, & Adelgais, 1998; Rekrut, 1994; Topping, 2001) the gender of mediators and learners was counterbalanced in each of the experimental and control groups. The gender composition in the mediators’ group (51 boys and 49 girls) was similar to that of the learners’ group (45 boys and 55 girls). In order to avoid transmission of information among children in the same class regarding the nature of intervention children from each class were assigned to either an experimental or a control group. All children were assigned into experimental (49 pairs) and control (51 pairs) groups. The mean age of the mediators in the experimental and control groups was 105.45 (SD = 3.97) and 104.27 (SD = 4.08) months, respectively. The mean age of learners in the experimental and control groups was 81.70 (SD = 3.90) and 80.34 (SD = 4.73) months, respectively. In order to control for subjects’ verbal level, we administered two verbal subscales from the WISC-R95 (vocabulary and similarities). A one-way MANOVA of Treatment with the two verbal subscales as dependent variables revealed that the experimental group scored at about the same level as did the control group, $F_{(2,97)} = 2.07$, $p > 0.05$.

2.2.1. Parent’s sample

Parental years of formal education was similar for experimental and control groups; mothers $– \chi^2(2,100) = 0.78$, $p > 0.05$, fathers $– \chi^2(2,88) = 0.51$, $p > 0.05$. Parental level of occupation was classified on an ordinal 5-point scale starting from 1 (e.g., unemployed) to 5 (e.g., academic profession, manager). The parents’ level of occupation was similar in both experimental and control groups; mothers $– \chi^2(2,100) = 0.13$, $p > 0.05$, fathers $– \chi^2(2,100) = 2.43$, $p > 0.05$. In order to control for the socioeconomic status (SES) of subjects, a SES index was constructed using principal component factor analysis. SES is considered to be an important determinant of children’s cognitive level (e.g., Espy, Molfese, & Dilalla, 2001; Seifer, 2001; Turkheimer, Haley, Waldron, D’Onofrio, & Gottesman, 2003; White, 1982) as well as on the parents’ MLE strategies (Korat et al., 2008; Tzuriel & Ernst, 1990). The analysis was based on demographic variables of the parents’ occupation, education, and living condition (e.g., a ratio of number of rooms at home by number of family members). The factor analysis revealed one factor with an eigenvalue higher than 1.00 that explained 54% of the variance. Following the factor analysis findings a SES index was calculated for each subject based on a weighted score of factor loadings $\times$ demographic variable. Comparison of the experimental and control groups revealed no significant differences on the SES index, $t_{(99)} = 0.17$, $p > 0.05$.

2.2. Measures

2.2.1. Observation of mediation interaction (OMI)

The OMI (Klein, 1988, 1996; Klein & Alony, 1993; Klein et al., 1987) is a rating scale based on the first five MLE criteria. These criteria were empirically defined and developed into an observation scale of parent-child interactions and adapted later for peer interactions (e.g., Shamir & Tzuriel, 2004; Tzuriel & Shamir, 2007, 2010), sibling’s interaction (Klein, Zarur, & Feldman, 2002; Klein et al., 2003; Tzuriel & Hanuka-Levy, 2014) and teacher-students’ interactions (Tzuriel, 2011b; Tzuriel et al., 1998). The OMI provides a profile of mediation that is based on the five MLE strategies as follows: Intentionality and Reciprocity (Focusing), Mediation for Meaning, Mediation for Transcendence, Mediation of Feelings of Competence and Mediation for Regulation of Behavior.

In addition to the five MLE strategies we included a non-mediation behavior, activation, found to be used significantly less in children trained how to mediate than in children trained in alternative program (Shamir & Tzuriel, 2004; Shamir et al., 2006). Activation refers to interactions in which the mediator is performing the task for the learner (nonverbal) or tells the learner the right answer (verbal).

In earlier studies, mother-child or peer dyads were videotaped during free-play and/or structured teaching situations and analyzed later with the OMI. In each interaction, mediators and learners alike were rated on the five MLE criteria by two trained observers. Both observers were trained for 30 h in rating mediation strategies; training included theoretical understanding of the MLE criteria and mostly by observing and analyzing videotapes depicting mediation processes. The OMI was adapted for the observation of kindergarten children interacting with their parents (Bettan & Tzuriel, 2007; Isman & Tzuriel, 2008; Tzuriel, 1999; Tzuriel & Eran, 1990; Tzuriel & Ernst, 1990; Tzuriel & Hatzir, 1999; Tzuriel & Weiss, 1998) in peer-mediation (Shamir & Tzuriel, 2004; Shamir et al., 2006, 2007; Tzuriel & Shamir, 2007, 2010) and siblings’ mediation studies (Klein et al., 2003; Tzuriel & Hanuka-Levy, 2014).

In the present study mother-child and peer interactions were carried out in structured teaching situations. Each interaction was videotaped for 20 min and later analyzed by the OMI. In mother-child interactions each mother was asked to teach her child two types of tasks (see Procedure) requiring abstract level of thinking. In peer mediation each older child was asked to teach his/her younger peer complex problems requiring inferential thinking (see Procedure). Each behavioral category of mediation was coded and given a score of 1.

The reliability coefficients of four studies on mother-child interactions with kindergarten and school age children were adequate ranging from 0.54 to 0.95 (Tzuriel, 1999). Similar reliability coefficients between 0.85 and 0.95 for the different MLE strategies were found in the context of peer mediation of school age children (Shamir & Tzuriel, 2004; Tzuriel & Shamir, 2010) and for infants (Klein, 1988). The reliability of the MLE strategies was tested in the current study by two experienced raters who were blind to the study hypotheses. Cronbach alpha coefficients of mother-child interaction on a sample of 10 pairs for the five MLE strategies were as follows: Intentionality and reciprocity, 0.79; meaning, 0.87; transcendence, 0.86; feelings of competence, 0.86; self-regulation, 0.90.

For some of the analyses there was a need to develop a composite measure of mother’s quality of mediation based on all MLE criteria. Since each criterion was found to have differential significance in predicting cognitive modifiability (e.g., Tzuriel, 1999) a simple average of the criteria would cause a bias. In order to construct a modified Quality of Mediation Index (QMI) we asked five clinicians with expertise in use of the MLE approach to rate each of the MLE strategies for their contribution to children’s cognitive modifiability. Each of the clinicians had at least 15 years of research experience. Interclass correlation showed an inter-rater reliability coefficient of 0.83. The average weighted score for the different MLE strategies were as followed: Intentionality and reciprocity (I), 1.60; meaning (M), 2.60; feelings of competence (C), 3.06; regulation of behavior (B), 3.20; transcendence (T), 3.60. The QMI was finally computed by multiplying the MLE score of each criterion by the weighted score and dividing it by the total MLE score. The computation is carried out by the following equation:

\[
QMI = \frac{\sum(I \times 1.60 + M \times 2.60 + C \times 3.06 + B \times 3.20 + T \times 3.60)}{\sum(I + M + C + B + T)}
\]
The division of the multiplied weighted score by the total sum of MLE scores enables the construction of an index that expresses the quality of mediation relative to its contribution to cognitive modifiability while controlling for the amount of mediation in each MLE strategy.

2.2.2. The Seria-Think Instrument

The Seria-Think Instrument (Tzuriel, 2000a) is a DA instrument aimed at assessment of process-oriented cognitive behavior in the mathematics domain. The test is based on a variety of arithmetic skills, especially seriating and math operations. The problems of the instrument require cognitive functions such as planning, self-regulation, systematic exploratory behavior, simultaneous consideration of several sources of information, and need for precision. The Seria-Think Instrument, $5 \times 5$ version (see Fig. 3), is composed of a wooden block, $12 \text{ cm} \times 12 \text{ cm} \times 10 \text{ cm}$ with five rows of holes, five holes in each row, a set of cylinders with various heights, and a measuring rod divided equally into 11 one-cm units.

In the first row of the block all holes have the same depth (1 cm); in the second row the depth of the holes increases progressively and in the third to fifth rows the depths of the holes is in a mixed order. Each task in the Seria-Think involves insertion of the cylinders into the holes so as to get lines of cylinders with either equal height, regularly increasing height, or regularly decreasing height above the surface level of the block. Children are asked to perform the task with as few insertions as possible; however, they are allowed to use the measurement rod as much as they wish.

The children are instructed to be as careful as possible to insert a cylinder in a hole only once. In order to avoid trial-and-error behavior they are encouraged to use the measuring rod as many times as they need to do. In order to solve the problems, the children must first predict the requested height, measure the depth of holes, calculate the requested length of the cylinder, and choose the correct cylinder from a pile of cylinders. The task requires not only comparing the depth of holes to the cylinders’ length for each hole but also comparing the result of one hole to the result of the next hole (and sometimes to results of all other holes) based on the task demands (increasing, decreasing, or equal heights). For most holes there is no way of knowing their depth without using the measuring cylinder.

The Seria-Think Instrument is administered in a DA mode, using a preliminary baseline phase followed by pre-teaching, teaching, and post-teaching phases. The preliminary baseline phase is aimed at familiarizing the children with the test materials and the specific rules required to solve the problems. This phase also includes two example problems. In the current study the pre-teaching, teaching, and post-teaching phases each contained 6 problems. In the pre-teaching phase the problems required placing the cylinders in an increasing order and in the post-teaching phase in a decreasing order. In order to solve the problems, children have to apply a four-step strategy (P-M-C-S): (1) predict the height of the cylinder above the surface level of the block, (2) measure correctly the depth of the hole, (3) compute the required length of cylinder (i.e., by adding depth to the predicted height), and (4) select the correct cylinder (some are longer than the measuring rod). The task requires comparing the results not only within each hole but also between holes. In teaching how to solve the problems, the mediator emphasizes the PMCS four-step strategy. The children are mediated for strategies of planning behavior (e.g., preparing the solution outside the holes before inserting the cylinders), restraint of impulsivity in data gathering, need for precision (e.g., measuring the depth of the hole and the length of cylinder), simultaneously considering multiple sources of information (e.g., depth of the hole, required height, length of cylinder), comparative behavior (e.g., comparing the depth of the hole to the required height), and exact computation (e.g., subtracting the depth of the hole from the cylinder’s length to get the correct height).

Responses are recorded according to three criteria: Outcome (accuracy of solution), number of insertions, and number of measurements required for solving the problem; the last two are process measures. These scores may reveal qualitative aspects about the children’s patterns of dealing with the problems. For example, a child who measures only rarely and makes many unnecessary insertions might be perceived as impulsive compared with a child who makes frequent measurements but fewer insertions, the latter considered to be more reflective.

Cronbach alpha reliabilities based on a sample of grade 1 children ($n = 48$) for pre- and post-teaching phases (using a $3 \times 5$ holes’ version), respectively, were: Number of measurements 0.37 and 0.66, number of insertions 0.78 and 0.85 (Tzuriel, 2000a). Cronbach alpha reliability for accuracy could not be computed because of a ceiling effect; most subjects reached the correct solution after the process of inserting and measuring. Cronbach alpha reliabilities were calculated based on the sample of the current study and the $5 \times 5$ version of the test. The children received the test three times—once before the PMYC in a static way (pre-teaching) and twice after the PMYC as part of the DA procedure (pre-teaching and post-teaching). Cronbach alpha reliabilities of accuracy scores for the three administrations were 0.76, 0.86, and 0.90, respectively. Cronbach alpha reliabilities for the three administrations of number of insertions were 0.71, 0.73, and 0.82, respectively and for number of measurements, 0.82, 0.88, and 0.92, respectively. The Seria-Think Instrument was validated in several studies in Israel (Tzuriel, 2000a) and the Netherlands (Resing, Tunteler, De Jong, & Bosma, 2009) and is used as a clinical tool for assessment and intervention.

2.2.3. Analogies subtest from the cognitive modifiability battery (CMB)

The CMB (Tzuriel, 1995, 2000c) is a DA instrument designed for children from kindergarten to fourth grade. All analogies are based on four dimensions: Color, height, number, and position. After a preliminary-baseline phase in which the examinees are familiarized with the main dimensions of the test and the basic rules of solving classical type analogies (e.g., $A:B :: C:D$), the pre-teaching,
teaching, and post-teaching phases are administered. Scoring of the Analogies subtest is carried out by giving each correctly solved problem a score of 1; the maximal score for each phase (pre- and post-teaching) is 10. Cronbach-alpha reliabilities reported by Tzuriel (2000c) were 0.80 and 0.85 for pre- and post-teaching phases, respectively. Cronbach alpha reliability coefficients based on the current sample were 0.68, and 0.70 for the pre-teaching phase administered before and after the PMYC and post-teaching phase after the PMYC, respectively. The CMB has been validated in several studies in the UK (e.g., Lauchlan & Elliott, 2001) and in Israel (Tzuriel, 2000c; Tzuriel & George, 2009; Tzuriel & Shamir, 2007, 2010) and is used as a clinical tool for assessment and intervention.

2.2.4. Vocabulary and similarities subtests (WISC-R95)

In order to control for subjects' verbal level, two subscales from the WISC-R95 (Hebrew version) were administered: Vocabulary and similarities. The WISC-R95 (Wechsler, 1995) is a conventional intelligence test for children at ages of 6–16 years. We chose only these two subs tests as they proved to represent the verbal ability of children more than other subs tests from the verbal domain of the WISC-R95 (Jensen & Reynolds, 1982; Meesters, van Gastel, Glijn, & Merckelbach, 1998).

2.2.5. Children’s inferential thinking modifiability (CITM) test

The CITM (Tzuriel, 1989, 2001) is aimed at assessing young children’s ability to solve problems that require inferential thinking as well as their ability to modify their performance following a teaching phase. The CITM was used in the current study only as a tool for teaching the inferential tasks to the learners. The task requires systematic exploratory behavior, control of impulsivity, spontaneous comparative behavior, planning, inferential–hypothetical (“iffy”) thinking, and simultaneous consideration of multiple sources of information. Cronbach-alpha reliability coefficients of the pre- and post-teaching phases are 0.82 and 0.82, respectively (Tzuriel, 1989). The CITM validity were established in several developmental and educational studies (Samuels & Tzuriel, 1998; Tzuriel, 1989; Tzuriel & Eran, 1990; Tzuriel & Kaufman, 1999; Tzuriel & Weiss, 1998).

2.3. Pilot study

A pilot study was carried out with two goals in mind: (a) to examine adequate types of tasks for mother-child interactions in both free-play and structured situations, (b) to examine the type of dynamic assessment measure that is appropriate for the teaching phase of the peer mediation. Since the teaching phase is given by 3rd grade children to their peers in 1st grade, it was important to find out the adequacy of the teaching process as related to level of complexity and abstraction of the test, smoothness and fluency of teaching. There were two samples in the pilot study. The first sample was composed of mother-child dyads (n = 10), the age of the children being 8–9 years. Each dyad was videotaped during 15 min of a free-play situation (e.g., memory game, puzzle, letters game, magic games) and 15 min of a structured situation (e.g., cognitive analogy tasks using figural and pictorial elements). The second sample was composed of 6 grade 1 children (n = 6) children ages 6–7 years. The children were given two dynamic assessment measures.

Detailed analysis of the mother–child interactions revealed that the structured situation triggered more verbal interactions than did the free-play situation and allowed better observation of the MLE strategies used. In addition, we found that the best tasks eliciting interactions were the Construction Analogies of the Children's Conceptual and Perceptual Analogical Modifiability Test-Construction Analogies (Tzuriel, 2002) and the Non-Verbal Matrices Test from the Cognitive Assessment System (Das & Naglieri, 1997). It was decided therefore to use these tasks for the mother-child interactions. Detailed analysis of the children's sample showed that the difficulty level of the Children's Inferential Thinking Modifiability Test (CITM, Tzuriel, 1989) was most appropriate to tap individual differences. It was decided therefore to use the CITM test as a DA measure to be administered to the learners in grade 1.

2.4. Procedure and design

Data gathering was composed of the following steps: (a) videotaping of mother-child interactions (n = 100 pairs), with the grade 3 children as mediators; (b) pre-intervention tests to mediators (c) application of the PMYC program to mediators in the experimental group and an alternative creativity program for mediators in the control group; (d) videotaping of peer mediation interactions (100 pairs); (e) post-intervention DA of the mediators in grade 3. The design of the study portraying also the procedure is presented in Fig. 2.

(a) Videotaping of mother–child interactions was carried out at the children’s homes. Mothers were asked to teach their children two structured cognitive tasks, analogical problems from the Children’s Conceptual and Perceptual Analogical Modifiability (CCPAM) - Construction Analogies test (Tzuriel, 2002, 2007) and Non-Verbal Matrices from the Cognitive Assessment Scale (Das & Naglieri, 1997), both tasks requiring higher-order abstract thinking. Although the CCPAM Construction Analogies test is composed of two sets of problems, conceptual and perceptual, the mothers were asked to teach their children only the nine conceptual problems. The Non-Verbal Matrices are composed of 1 training problem and 11 test problems. For each problem there were 6 alternatives to choose from at the bottom of the page.

Each mother received instructions (both written and oral) about the task and two training items for each task before starting the interaction. The instructions included the problem-solving rules and the solution but not how to teach her child. During instructions the child was in another room and was not exposed to them. The interactions lasted between 15 and 30 min; roughly equal time was given for each task. In order to analyze equal time sections for each dyad, only 15 min from each interaction were observed (7.5 min of each task). At the end of the interaction session each mother answered a demographic information questionnaire. Following the mother-child videotape session each interaction was rated by the OMI rating scale. Each mother-child interaction was then observed and rated for the frequency of using each MLE strategy. On the basis of these ratings mothers were then assigned to low- versus high-mediating groups using the Quality of Mediation Index (QMI). The QMI was constructed in this study to reflect the relative weight of each MLE strategy in terms of its importance to cognitive modifiability of children (see Measures). Mothers in each of the low- and high-mediating groups were further divided randomly into experimental (n = 49) and control (n = 51) groups.

(b) All mediators (grade 3) were given the Vocabulary and Similarities subscales of the WISC-R and the pre-teaching tests of the Seria-Think and CMB Analogies (Time A). All learners were given the CITM pre-teaching test (Time A). Testing was carried out individually in two 45-min sessions. All tests were administered by a team of graduate students who were trained for 15 h in administering the tests. The data gathered in this phase were compared later with post-intervention data.
The PMYC program was applied with the experimental mediators (see PMYC intervention program) during three weeks whereas the control group received an alternative program aimed at training of creativity; no mediation principles were taught in this group. The creativity program was applied in small groups of 8–10 children. This alternative program was chosen because it did not focus on mediation principles though it contributes to children’s cognitive development. The PMYC program was administered by expert trainers during 7 45-min sessions; the alternative creativity program was also administered by the same expert trainer for the same amount of time as the experimental group. The creativity program was based on the Young Thinker Program (Ganihar-Raz & Cahana, 1997) included topics such as brain storming, flexible search of solutions, critical thinking, and creative solution of conflicts. At the end of each program all mediators were instructed, for 1 h, on the CITM tasks; the CITM tasks were then used for teaching the learners in the next step of the peer-mediation session. It should be emphasized that instruction included understanding of the rules for solution but not the specific mediation strategies for teaching them. The purpose was to observe how the mediators in the experimental and control groups apply mediation strategies in a new context of teaching their peers the CITM problems.

(d) For each mediator in grade 3 a learner from grade 1 was assigned. The mediators in both the experimental and control groups were asked to teach the learners nine items from the teaching phase of the CITM. The teaching sessions were videotaped for 20–30 min between 2 and 15 days from the end of the intervention program. Before starting the videotaping session each mediator received an instruction page with a summary of the rules for solving the CITM problems, and recall of rules was verified. Only the first 20-min period of the video was taken later for analyzing the peer-mediation. The OMI, adapted for peer-mediation by Shamir and Tzuriel (2004), was used to obtain ratings of peer-mediated interactions. The children’s mediation strategies were later compared to the mother-child strategies, using the same observation parameters and technique.

Given that the time interval between the end of the program and the peer-interaction session varied across individual dyads, we calculated Pearson correlation coefficients between MLE strategies and number of days from end of program to the peer interaction session. The correlations ranged between 0.00 and 0.09 (ns) for the different mediation categories, allowing us to ignore the interval variable.

(e) All mediators at this stage were given two DA measures: The CMB Analogies and the Seria-Think Instrument. The DA measures included all three phases of the test: Pre-teaching (Time B), teaching, and post-teaching (Time C). Administration of a full DA at the end of the intervention allowed evaluation of the effect of intervention not only on static performance but also on the cognitive modifiability or “learning to learn” capacity that could have been changed by exposure to the PMYC program. Since one of the declared goals of The PMYC program is to change thinking processes, a novel DA approach should be adapted focusing on assessment of the modifiability of the cognitive process per se rather than merely outcome (Tzuriel, 2011a, 2011c).

The pre-teaching test was administered to the mediators individually during one session of 1 h. The teaching and post-teaching phases were administered during two sessions of 45 min each; the sessions were consecutive with a short break between them. The teaching and post-teaching phases were administered between 4 and 8 weeks after the pre-teaching phase. The tests were administered by trained examiners with previous experience.

3. Results

3.1. Effects of the peer mediation for young children (PMYC) program on mediators’ MLE strategies and activation behavior and on learners’ responsiveness to peers’ mediation

The purpose of presenting the effects of the PMYC program on MLE strategies in a peer mediation interaction is to replicate findings of earlier studies (Shamir & Tzuriel, 2004; Shamir et al., 2006, 2007; Tzuriel & Shamir, 2010). Although these effects have been shown previously we wanted first to establish the effects of the PMYC before comparing it to the effects of mother-child MLE interactions.

3.1.1. Mediators’ MLE strategies

The effects of PMYC program on MLE strategies of mediators was examined by one-way MANOVA of treatment with the five MLE strategies as dependent variables. The findings revealed a significant main effect of treatment, $F_{(5,92)} = 7.50, p < 0.001, \eta^2 = 0.29$, indicating higher mediation scores in the experimental group than in the control group, thus supporting partially expectation 1. Univariate analysis showed that the mediation level of the experimental group was significantly derived from mediation for transcendence and mediation of feelings of competence. The means, standard deviations and the univariate statistics for each MLE strategy are presented in Table 1.

<table>
<thead>
<tr>
<th>MLE strategies</th>
<th>Experimental M (SD)</th>
<th>Control M (SD)</th>
<th>$F_{(1,96)}$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intentionality &amp; Reciprocity</td>
<td>12.60 (11.76)</td>
<td>9.68 (8.33)</td>
<td>2.03</td>
<td></td>
</tr>
<tr>
<td>Meaning</td>
<td>9.25 (7.92)</td>
<td>8.04 (9.16)</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Transcendence</td>
<td>7.69 (6.57)</td>
<td>3.62 (3.78)</td>
<td>14.24 **</td>
<td>0.13</td>
</tr>
<tr>
<td>Feelings of Competence</td>
<td>23.25 (9.46)</td>
<td>13.42 (8.39)</td>
<td>29.68 **</td>
<td>0.24</td>
</tr>
<tr>
<td>Regulation of Behavior</td>
<td>6.42 (4.98)</td>
<td>5.50 (5.13)</td>
<td>0.81</td>
<td></td>
</tr>
</tbody>
</table>

** $p < 0.001$. 

Table 1

Means, standard deviations, and univariate analyses of mediators’ MLE strategies in the experimental and control groups.
Similar findings were found after controlling for the mediators’ socio-economic level, verbal ability (e.g., WISC-R Vocabulary and Similarities), and learners’ cognitive level (as determined by the pre-teaching CITM score), \( F(5,82) = 7.14, p < 0.001, \eta^2 = 0.30. \) Univariate analysis showed that treatment differences derived mainly from mediation for transcendence, \( F(1,86) = 15.63, p < 0.001, \eta^2 = 0.15 \) and mediation for feelings of competence, \( F(1,86) = 23.12, p < 0.001, \eta^2 = 0.21. \)

3.1.2. Mediators’ activation behavior in the experimental and control groups

In order to determine whether activation behavior was different in the two research groups we carried out independent t-tests with Treatment as independent variable. The control group (\( M = 1.94, SD = 3.57 \)) showed significantly higher activation score than did the experimental group (\( M = 0.63, SD = 1.52 \)), \( t(96) = 2.39, p < 0.05. \)

3.1.3. Learners’ responsiveness to peers’ mediation

According to expectation 3 the learners’ responsiveness to mediation of mediators in the experimental group should be higher than responsiveness to mediation in the control group. The learners’ responsiveness was measured by the five MLE strategies used in the interaction. For example, when a mediator asked for the color of an object and the learner responded, it was coded as mediation for meaning from the learner’s perspective. In the interest of clarity, the learners are labeled as experimental or control only because they were matched to their peers in the experimental or control groups. In spite of the fact that learners did not receive any intervention we expected that learners in the experimental group would demonstrate greater responsiveness than would their control counterparts. The type of responsiveness categories matched the MLE strategies: Reciprocity, meaning, and transcendence. Because of lack of responsiveness to mediation of feelings of competence and regulation of behavior (i.e., learners usually do not try to give their mediators feelings of competence or regulate the mediators’ behavior) these strategies were not included in the analysis. A one-way MANOVA of treatment was carried out with the three categories as dependent variables. There was a significant main effect of treatment, \( F(1,94) = 7.69, p < 0.001, \eta^2 = 0.20. \) The means, standard deviations, and the univariate statistics for each MLE strategy are presented in Table 2. As can be seen in Table 2, the results support expectation 2. Learners in the experimental group showed greater use of mediation strategies than did learners in the control group. The differences were significant in mediation for meaning and mediation for transcendence. Because of the large standard deviations relative to the means we conducted non-parametric analyses. Mann-Whitney U tests showed similar significant differences for mediation for meaning, \( Z = 2.41, p < 0.05, \) and mediation for transcendence, \( Z = 3.02, p < 0.05. \)

3.2. The interaction effect of mother-child MLE strategies and PMYC program on children’s MLE strategies

An interesting question of the current study was whether mothers will demonstrate higher MLE strategies than their children. We assume that mothers will show higher levels of MLE strategies than their children. On one hand it is plausible to assume that mothers would show higher level of MLE strategies when interacting with their children than those revealed by their children when interacting with their peers. It is due probably to their rich experience, and deep involvement and sense of responsibility toward their children. On the other hand, children participating in a structured program aimed at enhancement of mediation strategies such as the PMYC might develop a qualitative style of teaching and reveal higher MLE strategies than their mothers, in spite of their young age.

This question was examined by repeated-measures MANOVA of treatment (experimental versus control) by mediation agent (mother versus child) and the five MLE strategies the dependent variables. We included in the analysis a category of Activation (i.e., showing the solution rather than mediating). The activation behavior was found in earlier studies as contradicting mediation strategies and negatively related to cognitive modifiability (e.g., Shamir & Tzuriel, 2004; Tzuriel & Hanuka-Levy, 2014).

The analysis revealed a significant interaction of treatment \( \times \) mediation agent, \( F(6,90) = 4.31, p < 0.001, \eta^2 = 0.22. \) The means, standard deviations, and the repeated measures results for each MLE strategy are presented in Table 3. Three significant interactions of treatments by mediation agent were found for three MLE strategies: Intentionality and Reciprocity, Transcendence, and Feelings of Competence. These interactions are portrayed in Figs. 4–6, respectively. The findings show that in the experimental group children showed consistently higher mediation than mothers whereas in the control group mothers showed higher mediation than children.

Simple main effect analyses on the interactions showed that in the experimental group children received significantly higher mediation scores on Intentionality and Reciprocity, \( F(1,47) = 6.87, p < 0.05, \eta^2 = 0.13 \) (Fig. 4) and on Feelings of Competence, \( F(1,47) = 22.47, p < 0.001, \eta^2 = 0.32 \) (Fig. 5) than mothers. However, mothers and children showed about equal scores on mediation for Transcendence, \( F(1,47) = 0.88, ns \) (Fig. 6). Similar comparisons between mothers and children in the control group reveal no significant differences for Intentionality and Reciprocity, \( F(1,49) = 2.35, p < 0.05 \) and for Feelings of Competence, \( F(1,49) = 1.62, p > 0.05, \) whereas in mediation for Transcendence mothers show higher scores than children, \( F(1,49) = 15.06, p < 0.001, \eta^2 = 0.24. \) Mann-Whitney U nonparametric analyses were carried out separately for the experimental and control groups in two MLE strategies (due to the relatively high SD): Intentionality/Reciprocity and Transcendence. The findings showed that, similar to the parametric analysis, in the experimental group children scored higher than mothers on Intentionality and Reciprocity, \( Z = 1.97, p < 0.05. \) No significant results were found for mediation for Transcendence, \( Z = 1.00, p > 0.05. \) In the control group, however, mothers showed about the same scores as their children on Intentionality and Reciprocity, \( Z = 1.89, p > 0.05, \) but higher mediation for Transcendence than their children, \( Z = 3.39, p < 0.001. \)

In summary, children participating in the PMYC program show higher mediation strategies than their mothers whereas children

| Table 2 |
|---|---|---|---|
| MLE criteria | Experimental | Control | \( F(1,96) \) |
| | \( M \) | (SD) | \( M \) | (SD) |
| Reciprocity | 12.55 | (10.15) | 10.77 | (7.46) |
| Meaning | 13.64 | (9.87) | 8.55 | (9.06) |
| Transcendence | 0.93 | (1.92) | 0.28 | (0.4) |

\( * \) \( p < 0.05. \)

\( ** \) \( p < 0.01. \)
who had not learned how to mediate show either equal or lower
mediation strategies than their mothers.

Analysis of Activation scores reveal a significant interaction of
treatment /\textsuperscript{C2} mediation agent, \(F(1, 96) = 4.18\),
\(p < 0.05\), \(\eta^2 = 0.04\). The interaction is depicted in Fig. 7. Simple main effect analyses
on the interaction of activation showed that children received sig-
nificantly higher scores than their mothers in both the experimen-
tal, \(F(1, 47) = 5.15\), \(p < 0.05\), \(\eta^2 = 0.10\) and the control, \(F(1, 49) = 10.01\),
\(p < 0.01\), \(\eta^2 = 0.17\) groups. Nonparametric analyses showed similar
findings in the experimental, \(Z = 2.62\), \(p < 0.01\) and control groups,
\(Z = 3.01\), \(p < 0.01\). Among mediators the frequency of activation as
expected was higher in the control than in the experimental group,
\(F(1, 96) = 5.54\), \(p < 0.05\), \(\eta^2 = 0.06\). No significant differences were
found between mothers in the experimental and control groups,
\(F(1, 96) = 1.71\), \(p = p > 0.05\).

3.3. To what extent children’s quality of mediation is determined by
the mothers’ quality of mediation as compared with the effects of the
PMYC program?

One of the intriguing questions of this study is to what degree
there is a similarity between mothers’ and children’s MLE strate-

Table 3
Means, standard deviations, and statistics of repeated measures MANOVA of MLE strategies by treatment by mediation agent.

<table>
<thead>
<tr>
<th>MLE strategies</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mother (M)</td>
<td>Child (M)</td>
</tr>
<tr>
<td>Intentionality &amp; Reciprocity</td>
<td>7.60 (4.09)</td>
<td>12.60 (11.76)</td>
</tr>
<tr>
<td>Meaning</td>
<td>9.73 (4.73)</td>
<td>9.25 (7.92)</td>
</tr>
<tr>
<td>Transcendence</td>
<td>6.60 (5.37)</td>
<td>7.69 (6.57)</td>
</tr>
<tr>
<td>Feelings of Competence</td>
<td>16.54 (6.26)</td>
<td>23.25 (9.46)</td>
</tr>
<tr>
<td>Regulation of Behavior</td>
<td>5.94 (3.52)</td>
<td>6.42 (4.98)</td>
</tr>
<tr>
<td>Activation</td>
<td>0.19 (.57)</td>
<td>0.63 (1.52)</td>
</tr>
</tbody>
</table>

\* \(p < 0.05\).  
\** \(p < 0.01\).  
\*** \(p < 0.001\).
gies and to what extent participating in an intervention program aimed at enhancing the MLE strategies would change the correlation pattern. We studied these questions using two types of statistical analyses: Pearson correlation and hierarchical regression analysis.

3.3.1. Pearson correlations

Pearson correlations carried out between mothers’ and children’s MLE strategies showed that the Quality of Mediation Index (QMI) (see Method) of mothers was significantly correlated with children’s QMI in the experimental group, \( r = 0.37, p < 0.01 \), but not in the control group, \( r = -0.04, ns \) (Fisher Z = 2.06, \( p < 0.05 \)), thus supporting expectation 3. Similarly, mediation for feelings of competence was significantly correlated in the experimental group, \( r = 0.31, p < 0.05 \), but not in the control group, \( r = -0.07, ns \) (Fisher Z = 1.87, \( p < 0.05 \)).

3.3.2. Hierarchical regression analysis

In order to answer the above question, we applied a four-step hierarchical regression analysis in which the criterion (predicted) variable was the children’s QMI score (see Table 4). In step I we entered the verbal ability score to control for its possible effects on mediation. Verbal ability was computed as the sum of scaled scores of the Vocabulary and Similarities subtests. In step II and III the variables of training in mediation (PMYC program) treatment and the mothers’ QMI were entered, respectively. In step IV the interactions between the predicting variables were entered using a stepwise method. Mothers’ QMI added only 3% to the children’s QMI as compared to 20% contributed by training for mediation. The meaning of this finding is that participating in the PMYC program had a much stronger effect on the children’s quality of mediation than did the mothers’ quality of mediation. The significant interaction of treatment \( \times \) mothers’ QMI indicates that a positive and significant relation between mothers’ QMI and children’s QMI exists only in the experimental group \( (r = 0.37, p < 0.01) \) but not in the control group \( (r = 0.04, p > 0.05) \). In other words, the PMYC intervention program enhanced the correspondence between mothers’ mediation and their children’s mediation.

3.4. The effect of the PMYC program on children’s cognitive modifiability in process-oriented and outcome-oriented measures

Both measures (Analogies and Seria-Think) were administered three times: Before the intervention (Time A) and after the intervention (Time B and Time C). Times B and C were parts of the DA Pre- and post-teaching, respectively. This design allows not only assessment of pre- to post-intervention changes but also improvement on DA at the end of the intervention. The DA findings are considered to be an accurate measure of cognitive modifiability following the intervention program (Feuerstein et al., 2002; Tzuriel, 2001, 2011a, 2011c). Cognitive modifiability was assessed by the scores on Time C after controlling for measures on Times A and B, in a MANCOVA or ANCOVA analysis.

3.4.1. Process-oriented measures

The Seria-Think Instrument yields two process-oriented measures, number of insertions and number of measurements, and one outcome-oriented score. The effect of the PMYC program on cognitive modifiability was analyzed by a one-way MANCOVA in which the dependent variables were the scores in Time C (post-intervention, post-teaching) and the covariates were measurements in Time A (pre-intervention, pre-teaching) and Time B (post-intervention, pre-teaching). The findings indicate that, in general, the children in the experimental group improved their functioning significantly as compared with children in the control group, \( F_{(3.98)} = 3.29, p < 0.05 \), \( \eta^2 = 0.10 \). The means and standard deviations and univariate analyses of the Seria-Think measures are shown in Table 5. As can be seen in Table 5, the significant improvement was attributable mainly to the number of insertions (see Fig. 8) and the number of measurements (see Fig. 9), thus supporting expectation 4. As expected, no significant differences were found in the performance score of the Seria-Think Instrument. It should be noted that most children reach almost maximal performance at the end of the process.

As can be seen in Fig. 8 the number of insertions decreased slightly from Time A to Time B; the experimental group was not significantly different from the control group in Time A, \( t_{(98)} = 0.10, p > 0.05 \) or in Time B, \( t_{(98)} = 0.97, p > 0.05 \); however, from Time B to Time C, the children in the experimental group showed a steeper decrease in number of insertions than did children in the control group, \( t_{(98)} = 2.98, p < 0.01 \).

Fig. 9 shows that the number of measurements increased slightly from Time A to Time B. The experimental group was not significantly different from the control group in Time A, \( t_{(98)} = 0.09, p > 0.05 \) or in Time B, \( t_{(98)} = 0.07, p > 0.05 \); however, from Time B to Time C, children in the experimental group showed a greater increase in number of measurements than did children in the control group, \( t_{(98)} = 1.71, p < 0.05 \).

In summary, the experimental group showed after the intervention program an improvement from pre-teaching (Time B) to post-teaching (Time C) that was greater than that shown by the control group in both process-oriented measures. The improvement was revealed after a short teaching phase given within the DA procedure and is considered as indicative of cognitive modifiability.

3.4.2. Outcome-oriented measure (analogies)

The Analogies scores were analyzed by a one-way ANCOVA in which the independent variable was treatment (experimental versus control), the dependent variable was the Analogies score at Time C (e.g., post-teaching, post-intervention), and the covariates were the Analogies scores in Time A and Time B. The findings revealed a significant main effect of treatment, \( F_{(1,96)} = 4.37, p < 0.05 \), \( \eta^2 = 0.04 \), indicating that children in the experimental

Table 4

Hierarchical regression analysis of children’s QMI by treatment and mothers’ QMI.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Step I (β)</th>
<th>Step II (β)</th>
<th>Step III (β)</th>
<th>Step IV (β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Ability</td>
<td>0.18</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td>-0.45**(</td>
<td>-0.45**(</td>
<td>-0.44**(</td>
</tr>
<tr>
<td>Mothers’ QMI</td>
<td></td>
<td></td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>Treatment ( \times ) Mothers’ QMI</td>
<td>0.03*</td>
<td>0.23**(</td>
<td>0.26**(</td>
<td>0.29**(</td>
</tr>
<tr>
<td>R²</td>
<td>0.03*</td>
<td>0.20**(</td>
<td>0.03</td>
<td>0.03</td>
</tr>
</tbody>
</table>

* \( p < 0.05 \)

** \( p < 0.01 \)

*** \( p < 0.001 \)
The means and standard deviations of the number of insertions, number of measurements, and performance scores on the Seria-Think Instrument in the experimental and control groups before and after the PMYC program.

<table>
<thead>
<tr>
<th>Time</th>
<th>Experimental M (SD)</th>
<th>Control M (SD)</th>
<th>F(1, 92)</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Insertions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time A</td>
<td>70.92 (33.19)</td>
<td>71.53 (26.34)</td>
<td>8.18</td>
<td>0.08</td>
</tr>
<tr>
<td>Time B</td>
<td>59.92 (22.22)</td>
<td>64.37 (23.84)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time C</td>
<td>39.92 (14.21)</td>
<td>49.57 (17.86)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time A</td>
<td>26.04 (21.76)</td>
<td>25.67 (22.05)</td>
<td>5.39</td>
<td>0.06</td>
</tr>
<tr>
<td>Time B</td>
<td>27.41 (17.34)</td>
<td>27.16 (18.31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time C</td>
<td>45.88 (23.40)</td>
<td>38.76 (17.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time A</td>
<td>29.16 (2.38)</td>
<td>29.45 (1.77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time B</td>
<td>29.51 (1.80)</td>
<td>29.55 (1.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time C</td>
<td>29.57 (1.93)</td>
<td>29.43 (2.44)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: A = Pre-teaching/Pre-intervention, B = Pre-teaching/Post-intervention, C = Post-teaching/Post-Intervention.
* p < 0.05.
** p < 0.01.

3.5. Can the PMYC program compensate for low mother-child MLE strategies?

The major objective of the current study was to examine how the cognitive modifiability of children who had not benefitted from adequate mother-child MLE strategies is enhanced as a result of intervention for peer mediation. We anticipated a significant interaction between mothers’ level of mediation and treatment effects (experimental versus control) on children’s cognitive modifiability. More specifically, the differences between the experimental and control groups should be larger among children of mothers with low use of MLE strategies than among children of mothers with high MLE strategies. This expectation was examined separately in outcome-oriented (CMB Analogies) and process-oriented (Seria-Think) measures.

3.5.1. CMB analogies

In order to test this expectation, we carried out ANCOVA of treatment by mothers’ level of mediation (2 × 2), where the dependent variable was the CMB Analogies score at time C (post-teach
and the covariates were the CMB Analogies scores at times A (pre-teaching/pre-intervention) and B (pre-teaching/post-intervention). The analysis revealed a significant interaction, $F_{(1, 94)} = 5.69, p < 0.05, \eta^2 = 0.06$. In Table 6 we present the means and standard deviations of the CMB Analogies in Times A, B, and C. The interaction is portrayed in Fig. 11. Simple main effects analysis for each group of mothers’ level of mediation shows the following. In the group of low-mediating mothers, cognitive modifiability of children in the experimental group was higher compared with children from the control group, $F_{(1, 45)} = 8.79, p < 0.01, \eta^2 = 0.16$. In the group of high-mediating mothers no significant differences were found between the experimental and control groups, $F_{(1, 47)} = 0.23, p > 0.05$.

Simple main effects analyses were carried out separately for the experimental and control groups. The findings revealed that in the low-mediating mothers group children in the experimental group showed significantly higher cognitive modifiability than did children in the control group, $F_{(1, 45)} = 8.79, p < 0.01, \eta^2 = 0.16$. In the high-mediating mothers group no significant differences were found between the experimental and control groups, $F_{(1, 47)} = 0.23, p > 0.05$. The picture is different in the control group. As can be seen in Fig. 11 children of high-mediating mothers in the control group showed higher cognitive modifiability as compared with children of low-mediating mothers, $F_{(1, 47)} = 5.40, p < 0.05, \eta^2 = 0.10$.

3.5.2. Seria-Think Instrument

The interaction effects of treatment and mothers’ mediation level on children’s cognitive modifiability was examined also on the two process-oriented measurements as dependent variables. A MANCOVA of treatment by mother’s Level of mediation (2 x 2) was carried out where the dependent variables were number of insertions and number of measurements at Time C (post-teaching/post-intervention) and the covariates were the same variables at Time A (pre-teaching/pre-intervention) and Time B (pre-teaching/post-intervention). The findings showed no significant main effect for mothers’ MLE level, $F_{(3, 88)} = 0.63, p > 0.05$, nor any interaction of treatment by mothers’ MLE level was found, $F_{(3, 88)} = 0.35, p > 0.05$. These results confirm expectation 5 for the outcome-oriented measure (CMB Analogies) but not for the process-oriented measure (Seria-Think Instrument).

3.6. Structural equation modeling: the effects of proximal factors on mediators’ and learners’ cognitive modifiability

We examined the effects of treatment and mothers’ QMI on mediators’ QMI, and the effect of mothers’ QMI on children’s cognitive modifiability. More specifically we were interested to find out the relative effects of all variables on children’s cognitive modifiability and whether mediators’ QMI serves as a mediating variable between treatment and mothers’ QMI and the outcome measure of children’s cognitive modifiability. The schematic models of the SEM analysis are presented above in Fig. 1.

The SEM analysis is estimated by the measurement error and path coefficients as measured by the maximum likelihood (ML) method. Testing the fitness of the theoretical model to the data was carried out by a procedure suggested by Steiger (1990) and Kline (2011). Testing the fitness of a model to empirical findings is usually carried out by several indices of ML measures: Goodness of Fit Index (GFI), Comparative Fitness Index (CFI, Bentler, 1990), Root Mean Square Error of Approximation (RMSEA), the statistic of $\chi^2$, and the ratio of $\chi^2/df$. The model chi-square is the most basic fit statistic, and it is reported in virtually all reports of SEM analyses. The model is considered as fit when the $\chi^2/df < 3$ and is not

![Fig. 11. CMB analogies score by mothers’ mediation level and treatment before and after the PMYC program.](image-url)
significant. A model is considered also as fit to the data when the GFI and CFI are higher than 0.95, and the RMSEA is lower than 0.05 (Bollen & Curran, 2006).

Children’s cognitive modifiability scores were computed for each of the DA measures (i.e., mediators’ CMB Analogies and Seria-Think number of insertions and number of measurements, and learners’ (CITM) by means of a regression analysis. A cognitive modifiability index (CMI) was computed for each score. The CMI was computed by means of regression analysis in which the residual score on post-teaching (Time C) was extracted after controlling for the pre-teaching (Time B) score of the dynamic test given after the intervention. In other words, the residual of the post-teaching score was computed after controlling for the explained variance of the pre-teaching score; the residual values represent the unexplained variance left after subtracting the variance contributed by the pre-teaching score. This procedure is considered to be a better measure reflecting change than a simple gain score that has the disadvantage of possible ceiling effect and regression to the mean effect (Embretson, 1992). Thus, we computed three CMI, one for the CMB Analogies, two for the Seria-Think measures (i.e., number of insertions and number of measurements) and one for the learners’ CITM. Accumulating evidence from educational research provides indications that a score contributed by the pre-teaching score. This procedure is considered to be a better measure reflecting change than a simple gain score that has the disadvantage of possible ceiling effect and regression to the mean effect (Embretson, 1992) and future academic success (Haywood & Lidz, 2007; Sternberg & Grigorenko, 2002; Tzuriel, 2000a, 2000b; Tzuriel, Kaniel, Kanner, & Haywood, 1999).

Since mediators’ cognitive modifiability was measured by two instruments, performance oriented and process oriented, we carried out separate analyses for each. In order to test our expectations, we created three models to be analyzed by SEM analysis. The factors of mothers’ QMI, Treatment and mediators’ QMI were considered dually for each. In order to test our expectations, we created three models to be analyzed by SEM analysis. The factors of mothers’ QMI, Treatment and mediators’ QMI were identical in all three models, whereas the outcome variable was different in each model. The outcome variables in the first, second and third models were respectively: (a) mediators’ cognitive modifiability on the CMB Analogies, (b) mediators’ cognitive modifiability on number of insertions and number of measurements of the Seria-Think Instrument, and (c) learners’ cognitive modifiability on the CITM test. The findings are presented in Figs. 12–14, respectively.

Model 1. The SEM analysis revealed that Model 1 is adequate thus confirming expectation 6, \( \chi^2 = 2.69, df = 3, \chi^2/df = 0.90, p = 0.44; NFI = 0.916; CFI = 1.00; RMSEA = 0.00. \) As can be seen in Fig. 12 Mothers’ QMI and treatment explain significantly the mediators’ QMI (\( \beta = 0.16 \) and \( \beta = -0.46 \), respectively). The mediators’ QMI, in turn, explained significantly the mediators’ cognitive modifiability on CMB (\( \beta = 0.16 \)). The findings support our expectation that the L-I proximal factors explain significantly the L-II proximal factor of mediators’ QMI and that the mediators’ QMI explains significantly the mediators’ cognitive modifiability.

Model 2. The SEM analysis revealed that Model 2 is adequate thus confirming expectation 6, \( \chi^2 = 4.42, df = 5, \chi^2/df = 0.88, p = 0.848; NFI = 0.491; CFI = 1.00; RMSEA = 0.000. \) Fig. 13 of Model 2, shows that mothers’ QMI and treatment explain significantly the mediators’ QMI (\( \beta = 0.17 \) and \( \beta = -0.46 \), respectively). The mediators’ QMI, in turn, explained significantly the mediators’ cognitive modifiability on number of measurements (\( \beta = 0.23 \)) and number of insertions (\( \beta = -0.24 \)). As expected the two process-oriented outcome measures were significantly related (\( \beta = -0.40 \)). The findings confirm expectation 6 according to which the L-I proximal factors explain significantly the L-II proximal factor of mediators’ QMI.

Model 3. The third model refers to the effects of the mediation strategies used by the mediators on learners’ cognitive modifiability. The SEM analysis revealed that Model 3 is adequate thus supporting expectation 7, \( \chi^2 = 0.36, df = 3, \chi^2/df = 1.20, p = 0.948; NFI = 0.99; CFI = 1.00; RMSEA = 0.000. \) The findings, presented in Fig. 14, show clearly that the L-I proximal factors of mothers’ QMI and treatment explain significantly the mediators’ QMI (\( \beta = 0.17 \) and \( \beta = -0.45 \), respectively). The mediators’ QMI, in turn, explains significantly the learners’ cognitive modifiability (\( \beta = 0.18 \)). The findings support our expectation that the L-I proximal factors explain significantly the L-II proximal

![Fig. 12. Structural Equation Model (SEM) analysis: the effects of proximal factors on mediators’ cognitive modifiability in the CMB analogies.](image-url)
factor of mediators’ QMI and that the mediators’ QMI explain significantly the learners’ cognitive modifiability.

In summary, all three models support our expectations regarding the effects of proximal factors on children’s cognitive modifiability. In general, mother’s mediation strategies and the treatment (PMYC program) are the main factors affecting directly the children’s (mediators) MLE strategies whereas children’s cognitive modifiability (of either mediators or learners) is directly affected by the quality of mediators’ MLE strategies.

4. Discussion

4.1. The effect of the PMYC program on children’s MLE strategies

The findings reveal that children participating in the PMYC program used higher levels of mediation than the control children, in each of the five MLE strategies. However, significant differences were found in two MLE strategies: Mediation for Transcendence and Mediation for Feelings of Competence (Table 1). These findings coincide with the emphasis given in the PMYC program on generalized rules and principles of MLE and on rewarding the learner for attempts to solve the problems given. Similar findings were reported by Klein and Alony (1993) on infants and by Tzuriel and Shamir (2010) on school age children.

Klein and Alony (1993) studied a sample of mothers of 1-year-old infants who received the Mediation Intervention for Sensitizing Caregivers program (MISC, Klein, 1992, 2003; Lifshitz & Klein, 2007). The MISC program is based on the first five criteria of Feuerstein’s MLE theory and is aimed at improving the quality of mediation of early age caregivers. The researchers reported that mothers in the experimental group showed a significant improvement in mediation for Transcendence three years after the end of the program whereas mothers in the control group showed a decrease. Tzuriel and Shamir (2010) studied the effectiveness of the PMYC with a sample of 78 dyads of Grade 3 mediators who taught kindergarten learners analogies and math problems. Mediators in the experimental group showed significantly higher mediation for Transcendence than did mediators in the control group when teaching math. Mediators in the experimental group showed also higher mediation of Feelings of Competence than did mediators in the control group in teaching both analogies and math. It seems that experimental mediators internalized the mediational teaching style and applied it later when are asked to mediate to others. It seems that in spite of the fact that the MLE criteria are abstract in nature, it is possible to translate them into manageable behavioral referents that can be usefully applied even with young children.

These findings confirm partially expectation 1 and coincide with previous findings demonstrating the effectiveness of the PMYC in eliciting mediation strategies in young children (Shamir & Tzuriel, 2004; Shamir et al., 2006, 2007; Tzuriel & Shamir, 2010). It is intriguing to find out that the two MLE strategies found as most discriminating between the two groups were Transcen-
dence and Feelings of Competence. The ratio between the control and the experimental groups for these two strategies in the current study were, respectively: 1:2.12 and 1:1.73. Similarly, in three earlier studies (Shamir & Tzuriel, 2004; Shamir et al., 2006; Tzuriel & Shamir, 2010) it was reported that mediation for Transcendence and Mediation for Feelings of Competence were found with the highest ratio between the control and the experimental groups.

These findings shed light on the impact of the PMYC program in eliciting mediation strategies of young children. Young children might show spontaneously, in their interaction with their peers, some indications for adequate mediation, as evidenced in the control group. However, an intervention aimed at teaching MLE principles in a structured way and practicing them during short and supervised intervention (seven sessions) reveals a dramatic change in their mediational teaching style. The children used more principles and generalizations, offered more mediations relating to rules and insights (Transcendence) and used more rewarding and feelings of success (competence) with their peers. Consequently, these children acted less for their partners as compared with their control counterparts.

The results indicate also that children in the control group, devoid of the mediational repertoire acquired during the intervention, used significantly higher level of activation than the experimental group (i.e., the mediator shows or tells the answer to the learner rather than elicits a response leading to problem solving behavior). Children in the control group used the time given for teaching their peers to activate them rather than scaffold their behavior in a mediational way.

The learners’ responsiveness to mediation was evident in two MLE strategies: Meaning and Transcendence. In both strategies learners in the experimental group showed higher responsiveness than learners in the control group (Table 2), thus confirming expectation 2. This finding is of special importance as it indicates that learners in the experimental group benefit from an interaction with qualified peers (mediators) by showing higher level of responsiveness. One should bear in mind that the intervention in this study was applied to the mediators in the experimental group whereas the learners’ exposure to mediation was carried out indirectly, only during the peer-mediation phase. It should be noted also that the analysis was carried out only on three MLE strategies of the learners: Reciprocity, Meaning, and Transcendence. Naturally, the learners did not tend to self-regulate the behaviors of their mediators or provide them with feelings of competence. Responsiveness in these two categories was almost zero and therefore excluded from analysis. Similar findings were reported in an earlier study where learners in the experimental group showed higher level of responsiveness only in strategies of Meaning and Transcendence than the children in the control group (Shamir & Tzuriel, 2004).

4.2. The interaction effect of mother-child MLE strategies and PMYC program on children’s MLE strategies

The question whether there are differences between mothers’ and children’s MLE strategies in relation to the effects of the PMYC program are of importance because the answer to this question would provide an indication for cross generational transmission of MLE strategies. We expected that mothers will naturally show a higher level of mediation than their children. Young children do not have the opportunities, the experience, the language skills, and the awareness to the importance of mediation as compared with their mothers. However, an intervention for mediation with children might change the pattern of differences by tapering the mother-child difference. The findings indicate that in the control group, as expected, mothers showed significantly higher level of mediation than their children whereas in the experimental group children showed superiority over mothers though not in a significant way (Table 3 and Fig. 6). Mediation for Transcendence requires a relatively higher level of abstraction and verbal ability than other MLE strategies. The findings in the control group are explained by the fact that mothers who have more experience and higher abstraction skills than their children would use this strategy more frequently than their children. However, it is fascinating to see that in the experimental group
4.3. To what extent children’s quality of mediation is determined by the mothers’ quality of mediation as compared with the effects of the PMYC program?

The relation between parents’ and children’s mediation teaching style is transmitted by internalization processes during the formative years of development. Previous research has already indicated a correspondence between mothers’ and grandmothers’ mediation strategies (Ismail & Tzuriel, 2007) which was explained by internalization mechanisms. Our findings (Table 4) are surprising as they indicate that the treatment effect is stronger in predicting the children’s QMI (β = -0.44) than the mothers’ QMI (β = 0.14). The contribution of mothers’ QMI is expressed only in the significant interaction with treatment showing a significant relation between the mothers’ QMI and children’s QMI only in the experimental group (r = 0.37, p < 0.01) but not in the control groups (r = -0.04, ns). The lack of relation in the control group might be explained by the fact that internalization of mother’s mediation strategies at young age (i.e., 8–9 years old) is not sufficient by itself to be applied in a context of peer mediation. It seems that in order for an internalized mediation strategy to be applied children need a deliberate intervention aimed at actualizing the mediation strategies acquired from parents. In other words, children need a “maturing” process (i.e., intervention for mediation) to make their raw internalized mediation capacities ripe enough to be used later with others.

An interesting finding was that the relation between mothers’ and children’s MLE strategies has emerged only for mediation of feelings of competence (experimental group, r = 0.31, p < 0.05; control group, r = -0.07, ns). It might be that, relative to other MLE strategies, mediation of feelings of competence is an easier strategy to adopt and use later with others. However, this finding might also be contributed to the range of scores which was much higher for this specific strategy than for other strategies (see Table 3). Further research is required to establish the transmission of MLE strategies from parents to children as well as the effects of other mediation agents such as teachers and significant others.

4.4. The effect of the PMYC program on children’s cognitive modifiability in process-oriented and performance-oriented measures

As expected, the PMYC program was found to be effective in changing children’s cognitive modifiability on both process-oriented and outcome-oriented measures. One should bear in mind that the PMYC program is not based on teaching a specific content. It is rather a process-oriented program designed to teach children how to mediate to peers effectively, irrespective of the specific content. The contents of the tests used were definitely different from the PMYC activities; hence the superiority of the experimental over the control group in cognitive modifiability parameters is indicative of the powerful transfer effects of the peer-mediation training. As can be seen in Figs. 8–10 mediators in the experimental group improved their number of insertions (indicating control of impulsiveness, Fig. 8) and number of measurements (planning behavior, Fig. 9) as well as their analogical reasoning (outcome variable) from pre- to post-teaching phases of the DA (Time B to Time C) much more than did mediators in the control group. These improvements, supporting expectation 4, were in spite of the fact that both groups received an equal-time teaching phase as part of the DA procedure. The theoretical conceptualization behind these differences is that learning qualitative mediation strategies combined with their application in peer interaction helps mediators to be better learners in other contexts and become more cognitively modifiable. 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 more 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. In Vygotsky’s (1978) terms, the peer-mediation experience enabled the mediators to advance from a lower zone of proximal development (pre-intervention) to a higher zone of proximal development (post-intervention). Later studies by Tzuriel and Shamir (2007, 2010) have consistently supported the earlier studies showing positive effects of participation in the PMYC on cognitive modifiability.

These findings support the claim that since the declared goals of a cognitive intervention program is to change thinking processes and teaching learning how to learn, a novel DA approach should be adapted focusing on assessment of the modifiability of the cognitive process itself (Tzuriel, 2011c). Previous studies showed also that comparing pre- to post-intervention static cognitive scores does not necessarily demonstrate the effectiveness of a cognitive program and that a DA procedure was found to be successful in revealing the effects of the program (Tzuriel, 2011c; Tzuriel & Alfassi, 1994; Tzuriel & George, 2009; Tzuriel & Shamir, 2007, 2010; Tzuriel et al., 1999).

4.5. Can the PMYC program compensate for low mother-child MLE strategies?

The analysis of mediators’ cognitive modifiability by mothers’ QMI and treatment reveals that the PMYC training was more effective among mothers with low QMI than among mothers with high QMI (Table 6 and Fig. 11), thus supporting expectation 5 with respect to the analogies test. The significant improvement in analogical reasoning in the DA procedure given at the post-intervention phase (Time B to C) shown by children of low-mediating mothers in the experimental group indicates that the program compensates for the low mediation in this group. It should be emphasized that these children performed at the same level as children of high-mediating mothers. Thus, the program brought about homogeneity of cognitive modifiability of children.
in the experimental group without distinction between children of low- and high- mediating mothers. Among children of mothers with high QMI, as expected, no significant difference was found between children trained to mediate and non-trained children in each of the pre- and post-intervention phases (Times A, B and C). It seems that children from families in which mothers provide a high level of mediation do not need as much intervention as do children whose mothers provide a low level of mediation. These findings support the idea that Level II of proximal factor (peer mediation training) is more powerful than Level I of the proximal factor (mother’s mediation) in determining children’s cognitive modifiability as reflected in a DA procedure. This finding supports the constructivist’s approach (e.g., Brownstein, 2001; Rhodes & Bellamy, 1999) according to which an actual experience is a powerful factor in a learning process. In the current study’s specific context, a short-term intervention for peer- mediation has been revealed as more powerful than mothers’ mediation in determining their cognitive modifiability. This finding however requires further studies with different samples of children, including children with learning difficulties.

4.6. Structural equation modeling: the effect of proximal factors on mediator’s and learner’s cognitive modifiability

Feuerstein, Rand, and Hoffman (1979) made a distinction between distal and proximal determinants of cognitive development. The distal factors (i.e., poverty, socioeconomic status, organic elements, and emotional states), in spite of their importance, do not explain directly individual differences in learning, cognitive change, and cognitive development. The distal factors might correlate with learning ability, but they affect learning ability only through the “prism” of the proximal factor – MLE processes. MLE processes on the other hand, are considered as proximal factors of cognitive development because they explain directly and invariably the development of cognitive development. In the current study we suggest to conceive the proximal factor as composed of two levels of influence. Level I is related to mediation given by a mediation agent (e.g., parent, teacher, peers) whereas Level 2 is related to the experience of an active mediation to others. Based on a constructivists’ approach we hypothesized that Level 2 is associated with children’s cognitive modifiability more than Level 1. We tested this hypothesis in a set of three SEM analyses (see schematic model in Fig. 1). The findings on both measures of cognitive modifiability of mediators (Figs. 12 and 13) confirm our hypothesis regarding the two levels of causal explanation of cognitive modifiability. These findings support the theory that active involvement in mediation to others is a powerful determinant of one’s own cognitive modifiability. It verifies what is known by layman psychology that the best way to develop learning skills is to actually teach these skills. It is interesting to note that both process-oriented measures (i.e., number of insertions and number of measurements) have emerged as significant predictors of cognitive modifiability in spite of the fact that both are interrelated measures of children’s planning and self-regulating skills. The first represents a tendency to control impulsivity and the second a tendency for cautious inspection and repeated measurement of objects before selecting them as correct answers.

Another intriguing result was that treatment has emerged as a more powerful factor in explaining mediators’ QMI ($\alpha = 0.46$) than the mothers’ QMI ($\alpha = 0.16–0.17$). The Treatment’s predictive strength was found in spite of the fact that Treatment is a binary variable (experimental = 1, control = 2) whereas Mothers’ QMI contains multiple levels. This finding verifies further, from a different statistical angle, that the effects of intervention for peer mediation are more powerful than mothers’ QMI in determining children’s cognitive modifiability.

The theoretical model was also confirmed as regard the learners’ cognitive modifiability. As can be seen in Fig. 14 the learners’ cognitive modifiability was significantly explained by the mediator’s QMI, which in turn was explained by treatment and mothers’ QMI (of mediators). It should be emphasized that in spite of the fact that the teaching phase where learners were exposed to mediation by their peers was relatively short (i.e., 60 min) it has an impact on performance of learners. Qualitative peer mediation is effective mainly because of the MLE strategies used. Mediators used MLE strategies in teaching their young counterparts how to make comparisons, systematically explore the problem, use specific task related strategies, inhibit impulsivity, and use verbal tools to solve the problems correctly.

These findings raise some practical implications in terms of cost-effectiveness consideration. For example, one can ask whether it is better to invest directly in intervention with children, preparing them to be better mediators and consequently develop better learning skills or investing in developing parental mediation skills. In the current study we did not use an intervention for mediation with mothers. However, considering the impact of intervention with children against spontaneous natural mediation of mothers raise the question of what is the most effective way to impact children’s cognitive modifiability, a question that is waiting for further research.

As expected the number of measurements during the problem solving process was negatively related to the number of insertions. That relation indicates that the more measurements were taken the less insertions were made. It is interesting to note that our SEM model was empirically corroborated in both type of measures; performance (analogies) and process. The mediators’ QMI (Level 2) was explained by both the mothers’ QMI and treatment (Level 1) whereas the cognitive modifiability of the mediators was explained only by the mediators’ QMI (Level 2). These findings confirm our theoretical distinction between Level 1 and Level 2 of proximal factors. It is possible though that intervention with mothers to enhance their mediation skills would make their mediation skill a more potent factor in determining their children’s cognitive modifiability.

4.7. Conclusions

In conclusion, this study provided evidence for the potential of peer mediation approach program to foster children’s cognitive modifiability and compensate for lack or deficient qualitative mother-child mediation strategies. In further studies it is suggested to explore the effects of other mediation agents such as fathers, siblings and grandmothers, especially in families of low socioeconomic status and children with special needs. Some evidence for the effectiveness of peer mediation was reported with children with learning disability mediating to their peers who were also with a learning disability (i.e., Trabelsi et al., 2015) but more studies are required to establish these findings.

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References

