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ABSTRACT

This study investigated the effects of an inductive reasoning training program on children's performance on intelligence test tasks, the range of transfer, the long-term effects of training over 4 months, and the effectiveness of group training. Participating were 47 third-grade children of average ability. The 23 children randomly assigned to the training condition received a 3-week course in inductive reasoning in ten 30-minute sessions. The training program consisted of six forms of inductive reasoning tasks: (1) generalization; (2) discrimination; (3) cross-classification; (4) recognizing relations; (5) discriminating relations; and (6) system formation. Abstract material was used in 15 percent of the tasks. The remaining 85 percent consisted of either concrete material, such as blocks or picture and figure problems from the children's everyday life. Children were trained in groups of three or four, by six researchers who were not involved in administering the pre- or posttests. Control group classes completed the regular school curriculum. The Raven Coloured Progressive Matrices Test and arithmetic tasks were used as a pretest, immediate posttest, and posttest four months later. Results indicated that there was a significant, positive training effect on children's performance on inductive reasoning tasks. Far-far transfer was also observed, because the children were able to solve arithmetic problems involving relations between numbers and their common attributes which related to inductive reasoning, in which they had received no training. (Contains 43 references.) (Author/KB)

Accelerating Intelligence Development Through an Inductive Reasoning Training

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Running Head: Accelerating Intelligence Through Inductive Reasoning

Abstract

The present study investigated the effects of an inductive reasoning training program for teaching children (Klauer, 1989b). The experiment assessed the effects of training and the range of transfer of the training achieved. The subjects were 47 third grade primary school children of average ability. Children from the training condition (N = 23) received a three week course of training (ten 30-minute sessions). The results demonstrated a significant, positive training effect on childrens' performance of inductive reasoning tasks. A near-far transfer was observed, i.e., children were able to solve tasks in which they had not been trained. These effects persisted for four months. Far-far transfer was also observed, because the children were able to solve arithmetic problems which relate to inductive reasoning, in which they had received no training. Implications for training children within the context of regular schools and the range of transfer are discussed.

Accelerating Intelligence Development Through an Inductive Reasoning Training

INTRODUCTION

In most human endeavours, including science, we can distinguish two forms of reasoning, i.e. inductive and deductive. Both forms are considered higher-order thinking skills. According to Willis, Hovey and Hovey (1987) a higher-order thinking skill is the ability to absorb information, organize it into meaningful units, identify the essentials or principles included in the information, and then put them to work solving other problems. Inductive reasoning is described as deriving a general principle from specific examples (see among others Jacobs, 1982). In inductive reasoning, for instance, investigators observe a number of facts, find a pattern, generalize the pattern into a "law" or organizing principle, and then explore whether and to what extent the principle could be applied in practice, or try experimentally to discover the boundaries of possible applications.

An illustrative example of this form of reasoning is Kepler, who studied the data on planets, analyzing the numbers in all kinds of ways, before discovering a striking relationship between a planet's distance from the sun and the time it takes to complete an orbit. Darwin devoted years to examining the essential statistics of different species before formulating the principle of natural selection (Lightman, 1997).

A recurrent question is whether training in higher-order thinking skills, for instance inductive reasoning, affects the level of intelligence as measured by traditional tests. The aforementioned issue does not only concern raising the level of intelligence test scores; the question as to whether a change in cognitive representation has occurred is just as important.

Many researchers postulate that higher-order thinking skills are essential for learning, and inductive reasoning is considered a basic higher-order thinking skill (Csapo, 1997). Adey and Shayer (1995), for instance, have shown that the greater the mastery of higher-order thinking skills, the more children benefit from regular education. Besides Adey and Shayer (1995), Resnick (1987) emphasizes the teachability of higher-order thinking skills and argues that the activation of higher-order thinking is necessary even in basic skills like learning to read, write and do mathematics. As a consequence, different training programs emerged based on diverse theoretical approaches to higher-order thinking skills. In all the various studies in which training programs were conducted, the assumption was made that higher-order thinking skills can be trained. Besides trainability, another important issue is whether the programs bring about a change in cognitive representation.

In general one can distinguish three mainstream theories of cognitive representation (Tomic & Kingma, 1996). The first theory was developed by Piaget, the second by Bruner, and the third by Vygotsky. The latter theory was worked out in greater detail by Galperin and others. However, the abovementioned theorists and the researchers who conducted experiments according to the three classic theories think quite differently about the effects of training higher-order thinking skills. A survey of various training experiments shows that different evaluation standards are used to measure training effects (Kingma, 1981; Tomic, Kingma, & TenVergert, 1993; Tomic, 1995a; Tomic, 1995b; Tomic, & Klauer, 1996). This means that researchers disagree as to when it can be assumed that a child's cognitive representation has changed.

Transfer as a Criterion for Evaluating the Success of Training

The concept of transfer is a conditio sine qua non for observing any change in cognitive representation. One of the most important detailed and feasible standards was devised by Brainerd (1975a, 1975b), who describes the success of training in terms of near-near transfer, near-far transfer and far-far transfer. In the first instance, the posttest contains the same problems that the subjects have been trained in. The point is to study whether the children trained in these tasks score better on the posttest than the control group children, who receive no training. In the case of near-far transfer, the posttest presents problems related to the children's training but which were not included in the training program. A training effect is said to have occurred when the trained children are able to solve the near-far transfer problems better than the untrained children. Far-far transfer, finally, also requires the children to have made progress in other types of tasks. For example, they might demonstrate a significant improvement in solving seriation problems even though they have only been trained in conservation problems.

We will continue this section with an observation related to the three mainstream theories of cognitive representation and their criteria for evaluating the success of training. According to Piaget, for a training effect to reflect a change in the child's cognitive structure, it must meet the following standard, consisting of three criteria: First, the training or learning effect should be evaluated from the perspective of spontaneous cognitive development. The crucial question is whether training has brought about a change in the entire cognitive structure. Second, skills should have been transferred to concept areas in which the child has not been trained. Third, the training effect should be durable.

The first criterion implies that the child's cognitive level must be determined before and after training. With respect to the level after training, the researcher must establish that cognitive functioning has undergone a definite change compared to the pretest level. The focus of interest is to determine whether the learning experience has resulted in a more complex structure.

The second criterion is an operationalization of the first: the translation of the theoretical concept of change into measurable terms. Transfer means the application of newly acquired knowledge and skills in different situations. To measure the range of the transfer, the posttest includes problems related not only to the specific area in which the child was trained, but also to other conceptual fields. For example, if training involved conservation of number, then the posttest would include not only conservation of number problems but also conservation of quantity (Inhelder et al., 1974). However, even if a child can solve both types of conservation problems correctly (that is, in addition to finding the right answer the child also offers the right arguments for his solution), we still cannot conclude that training has given rise to a more complex cognitive structure. To determine whether this is so, the posttest must also contain different types of tasks enabling the researcher to examine whether the change in the cognitive structure is such that we can detect an improvement in representation (Tomic & Kingma, 1996).

Determining a change in the cognitive structure is a necessary, but inadequate, criterion for determining whether training has been successful. The change observed must also meet the third criterion: it must be durable. In the Geneva training studies the long-term effectiveness of training is established by means of a second posttest administered a few weeks after the first one.

The sharp rise in the number of training experiments in which children were taught Piagetian concepts culminated in a gigantic database concerning training effects.

Researchers within the action psychology approach also formulated criteria for evaluating the success of training. The standard used by Galperin to determine the success of a course of training is highly similar to the requirements set by Piaget for successful training. Broadly speaking, Galperin's requirements (Obuchova, 1966) consist of the following elements: First, instruction must induce a transferable structure of action. Second, the effect of training must be durable.

To determine whether training has resulted in a transferable action structure, children are given a wide range of tasks to perform after being trained. These researchers do not use the term transfer, however; rather, they talk of research into the functioning of the learning outcome, indicating by this that in the case of a positive training effect, the action structure (meaning the representation) has changed. Such a change can be deduced from the children's performances on the three types of transfer problems described previously. A significant similarity to Piaget's standard with respect to the assessment of training effectiveness is, therefore, the inclusion of a variety of tasks set for the children on the posttest.

The second requirement, that the effect of training should be durable, also resembles Piaget's standard. Closer analysis reveals that Galperin's standard for evaluating the success of training is in fact much stricter than Piaget's criterion (Kingma, 1981). When these strict criteria are met, one has a sound basis to decide that, first, an action has been internalized and, second, consequently that cognitive representation has therefore advanced to a higher level.

Many educational experiments employ Bruner's method for inducing a conflict between the forms of representation (appearance and reality). In most of these studies, researchers have not included a check to determine whether representation has been influenced by learning. According to them, the child's ability to find successful solutions to the tasks in which it has been trained is often decisive in determining whether training has been successful (see Kingma, 1981).

Bruner's ideas concerning the positive influence that education has on cognitive development appeals to a great many teachers. While it is true that Bruner's pedagogic instructions have been adopted, the issue of actual teaching success, i.e. a change in representation, is never raised.

In the sixties and seventies many American researchers shared a great deal of optimism about the possibility of influencing cognitive development through short-term training. In general, research could be characterized by simple training experiments conducted in specific well-controlled settings and producing small-scale significant but nevertheless weak effects (Kingma & Koops, 1988). In most of these studies, researchers have not included a check to determine whether representation has been influenced by learning. If the results of these American studies are analyzed by applying Piaget's standard for measuring the effect of training, as well as his criteria, then they appear to have produced rather specific, short-term training effects with only a small degree of transfer. What stands out is that many of these studies do not even bother to investigate durability of effects (Kingma & Koops, 1988).

Despite the large number of researchers who took Bruner's ideas concerning the development of representation as the starting point in designing their training studies, more than 97 per cent of these studies did not investigate whether training did in fact bring about a change in the students' representation (see Kingma, 1981).

Nevertheless, according to Piaget and Galperin, only when stringent criteria for evaluating training effects are met, i.e. when the child can solve a wide range of transfer problems after training, and when the results of training are durable, can one conclude that the child's representation has changed.

Training for Inductive Reasoning

Klauer designed a complete program for training inductive reasoning skills (Klauer, 1989c; Klauer, & Phye, 1994). The rationale of the training program is that the aptitude of inductive reasoning consists of cognitive processes that refer to using analogies, calling on psychological processes like generalization, discrimination, and a metacognitive monitoring strategy that implicates the checking of objects and relationships for similarities and/or differences. The purpose of the inductive reasoning training program is to invoke a change in cognitive representation.

To evaluate the success of a training program in cognitive development, stringent transfer criteria should be used. Far-far transfer is considered to be especially strong evidence that a change in the child's cognitive structure has occurred. For this reason we included some far-far transfer tasks in the posttests, i.e., arithmetic problems that relate to inductive reasoning not included in training.

During the last twenty years there has been growing interest in classroom instruction focusing on teaching and learning in small groups. According to some researchers (Slavin, 1990; Johnson & Johnson, 1992), this form of instruction, sometimes also characterized as team learning in small groups, seems promising for all children. Learning in small groups appears to be an intriguing instructional substitute for particularly heterogeneous classes. Therefore in the present study it was decided to administer training in small groups.

With regard to training, a type of feedback was chosen whereby after each task the child is told whether the given response is correct or incorrect. This type of feedback goes so far that after an incorrect response the child is told why the response given is not correct. This refers to the concept of corrective feedback as described by Bloom (1976). A great advantage of feedback is that the child is given the opportunity to change his solution strategy. Moreover, providing feedback leads to a more natural situation between trainer and child, since in the regular classroom situation the child is also used to hearing from the teacher whether the answer to a question is correct or incorrect.

The purpose of the present study was to investigate the effect that a training program in inductive reasoning has on childrens' performance on intelligence test tasks and the range (bandwidth) of transfer according to the criteria of Piaget and Galperin, in order to conclude whether cognitive representation has changed. Second, in addition to any observed effects, it seemed important to also investigate the durability of the observed effects. To study the after effect of training, an interval of four months was chosen, which satisfies both Piaget's and Galperin's stringent criteria for successful training. Third, an important goal was to determine the range or types of transfer induced by the training program. The fourth issue was whether training could be implemented in and was effective when administered in small groups (to enable children to provide feedback to each other) rather than on an individual basis. Two advantages of this approach are that it is an attempt to do justice to standard teaching practice and that children can provide each other with feedback about their solutions to inductive reasoning tasks (Kingma & TenVergert, 1993a, 1993b).

Method

Participants

The study was conducted at a primary school that has a population of about 220 students from kindergarten to sixth grade. The population consists of students of a relatively great ethnic diversity. The school is situated in the suburb of a city of about 100,000 inhabitants.

Forty-seven third grade primary school children from two classes participated in this investigation. The experimental and control groups consisted of two classes from each grade. The third grade level was chosen in order to compare findings with similar populations in previous training studies (Klauer, 1989a, 1990a, 1990b, 1992; Phye & Sanders, 1993; Resing & Verbraeken, 1993, Tomic, 1995, Tomic & Klauer, 1996). Out of 23 children in the experimental group, there were 12 boys and 11 girls. The experimental group had a mean age of 82.4 months, S.D. = 3.6, and a mean IQ row score of 8.4, S.D. = 1.6. The control group consisted of 24 children and was made up of 14 boys and 10 girls. The control group had a mean age of 81.2 months, S.D. = 4.0 and a mean IQ row score of 8.9 and S.D. = 1.8. The Raven's Coloured Progressive Matrices Test (1990) was used to measure (fluid) intelligence. All children were treated in accordance with American Psychological Association guidelines for human subjects.

Design

In the present study a two-factor pretest-posttest-control group design was used (Cook & Campbell, 1981). The first factor concerns the training and has two levels: (1) training (experimental group), (2) no training (control group). The effect is the second factor (two posttests) and has two levels: (1) scores on the Raven Coloured Progressive Matrices Test, and (2) scores on arithmetic tasks.

During the pretest, 47 third grade primary school children were administered the Raven Coloured Progressive Matrices Test, Set A (Raven, Court, & Raven, 1990). No other tests were administered. The assignment of classes to the experimental (training) condition (N = 23) and the control condition (N = 24) was random. The 23 children from the experimental group received training - ten 30-minute sessions - on each school day during a period of three weeks. Within the same time frame, their control group counterparts - 24 children - had to complete tasks from the regular school curriculum. One day after training, the first posttest was administered (consisting of Raven Coloured Progressive Matrices Test, and arithmetic tasks) to the trained children and their counterparts in the control group. This test was repeated four months after the first posttest was administered.

Analyses were conducted to determine the main effects of training on immediate and delayed near-far and far-far transfer performance of the trained and untrained group of children. To test the significance of differences between trained and untrained children, an analysis of covariance was conducted. During data analysis we controlled for variation in age and intelligence between conditions. Within each condition, however, there was variation concerning the two variables. The level of statistical significance was established at $p > .05$.

Materials and Procedure

Training. A training program was used which was designed for the development of inductive reasoning and to foster problem-solving strategies in the domain of inductive reasoning (Klauer, 1989b). In the training program there are six forms of inductive reasoning tasks, namely generalization (similarity between attributes), discrimination (difference between attributes), cross-classification (similarity and difference between attributes), recognizing relations (similarity between relations), discriminating relations (difference between relations) and system formation (similarity and difference between relations). The program includes 120 tasks. In fifteen percent of the tasks, abstract, meaningless material is used. The remaining 85% consists either of concrete material, such as blocks that could be manipulated by the children or picture and figure problems from the children's everyday life (for more details about the training program see Klauer & Phye, (1994) and chapter .... in this volume. All the tasks were administered to the children. It was a fixed trial training experiment. The training program is designed for at least ten sessions. All training tasks were administered during eight sessions, 15 tasks per session. During the last two sessions (ninth and tenth) all training program tasks were reviewed. Previous research shows (Klauer, 1989a, 1990, 1992; Tomic, et al., 1993, Tomic, 1995) that all materials, the inductive reasoning program, and the training procedure employed in the experiment are appropriate for average third-grade children.

Following the pretest, the children assigned to the training group received treatment each school day for a period of three weeks. Each of the ten training sessions took about 30 minutes. The children assigned to the training group ($\underline{N}$ = 23) were trained in six groups (five groups of 4 children, and one group of 3 children) by six researchers, who were not involved in administering the pretests and posttests.

Prior to training the trainers were briefly instructed in the program's rationale and the training approach. Because trainers changed groups after two sessions, not every group of children got the same trainer during all sessions. At the beginning of the first training session, the child was given the opportunity to become familiar with the questions. When the child gave an incorrect response in a training trial, the researcher asked: "How do you know that?" or "Can you demonstrate that?" The child was then asked to perform the item again until he or she gave a correct response and understood the principle of this type of problem solving. When a child gave a wrong solution or was unable to respond correctly, the trainer or fellow students could provide some assistance. When the children generated different solutions, all these alternatives were evaluated. After a positive evaluation the children were allowed to proceed. Due to the importance of feedback in fostering transfer (Kingma & TenVergert, 1993a, 1993b), the children got feedback from each other as well as from the trainer.

Transfer. Pretest and posttests, administered prior to and following training, consisted of the Raven Coloured Progressive Matrices Test (1990), Set A. The test was scored according to the instructions given in the test manual. The test was administered to the training and the control group prior to training (pretest), after training (as a measure of near-far transfer), and four months following training (second or delayed posttest) as a measure of the durability of training for transfer. Before and after intervention an identical test was administered. A strong advantage of this option is that the intervention program does not specifically prepare the children for the immediate and the delayed posttests, for "teaching the test" is a frequent phenomenon in intervention studies. In the present study this phenomenon is non-existent. The posttests also consisted of arithmetic tasks as a measure of far-far transfer.

The Raven Coloured Progressive Matrices Test tasks are non-verbal intelligence tests; they are known as measures of fluid intelligence. These tests can be administered without the use of language. The child who is administered this type of test does not need knowledge of a specific language to solve the problems or tasks presented. This does not at all mean that language command has no influence on the ability to give the right solution. On the one hand one cannot prevent language proficiency from playing a role in thinking, on the other hand we should strive to only apply (sub)tests that reduce language influence by using, for instance, merely geometrical figures. The test was administered and scored according to the instructions given in the test manual.

The pretest and posttests were administered on an individual basis. An important reason for individual testing is the fact that young children are little motivated to work independently on their test tasks. Administration on a group basis also measures their ability to concentrate and not merely intelligence. Test administration in large groups also requires classroom management. Besides, administration on an individual basis makes it possible to observe the child's method of working. The test administrator did not know which children belonged to the training or the control group.

Arithmetic tasks. During training the children were encouraged both to describe relations between objects and to name the common attributes of objects. Various objects familiar to the children were used; arithmetic tasks, however, were not. An arithmetic test was constructed asking children to discover relations between numbers and to reveal common attributes of numbers. Using inductive reasoning strategies, arithmetic tasks could be solved. The arithmetic test consisted of three parts and 20 items. Relatively little research has been done on far-far transfer.

In general, children of this age, about 6.8 years, possess the acquired arithmetical knowledge to solve such tasks. However, they are not sufficiently able to understand relations between the given numbers, nor are they able to name the common attributes of those numbers. The range of transfer between the training tasks and the arithmetic tasks would be considered far-far transfer, because in the training program no numbers were included. Following the Raven Coloured Progressive Matrices Test (near-far transfer), the arithmetic test was also administered as a posttest. The arithmetic test was administered immediately after training and again four months following training. An introductory trial was given to familiarize the child with the arithmetic problems (see Figure 1).

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insert Figure 1 about here

Results

Overall comparisons among groups indicated that the average total scores of the training group on the near-far transfer tasks were significantly higher than those of the control group on the first (immediate) near-far posttest, $\underline{F}(1, 46) = 9.7$, $\underline{p} < .001$. On the second posttest (four months later) the near-far performance of the training group was still significantly better than that of the control group, $\underline{F}(1, 46) = 6.0, 10.0$, $\underline{p} < .05$. The difference between the experimental and the control group was still significant.

No significant interaction effects were observed. Thus, it is clear that training in inductive reasoning successfully induced near-far transfer in reasoning skills, and that this transfer effect persisted at least four months after training (i.e., the second posttest). Means are shown in Table 1.

Insert Table 1 about here

In order to determine whether the training program induced an immediate and delayed far-far transfer concerning childrens' inductive reasoning skills, the acquired childrens' scores on the arithmetic test administered following training were analyzed. Analysis showed that there is transfer to arithmetic tasks. Significant main effects were observed. The experimental group's arithmetic task scores were significantly higher than the scores of the control group (Arithmetic first posttest $F(1, 46) = 13.1$, $p < .05$. Arithmetic second posttest $F(1, 46) = 14.8$, $p < .05$). These results demonstrated that training in inductive reasoning induced a far-far transfer, i.e. that students were able to apply the newly acquired skills in another conceptual domain, arithmetic, after four months as well. The results show a significant far-far transfer to inductive reasoning skills in the domain of arithmetic.

Discussion

The present study investigated the effect of a training program in inductive reasoning on childrens' performance on intelligence test tasks and the range of transfer according to the criteria of Piaget and Galperin in order to conclude whether cognitive representation had changed. The durability of the effects was also investigated. In the study the range or types of transfer induced by the training program was determined.

Training in inductive reasoning was shown to be effective in teaching third grade primary school children inductive reasoning skills and strategies. This illustrates a strong indication that implementation of an inductive reasoning training program in small groups was successful. Besides the significant differences between the trained and untrained children, the positive training effects have implications that are important educationally. In order to depart as little as possible from current educational practice, the children were not trained on an individual basis as in Tomic, et al. (1993), but in groups. Durability was also demonstrated.

Researchers who are engaged in training inductive reasoning within the educational context are particularly interested in long-term effects. Training for transfer according to Piaget and Galperin, occurs when a more or less long-lasting change is observed in a child's ability to solve a certain type of problem as induced by a training program. A positive transfer effect is considered an indication of such a change. While influencing cognitive development, it is especially important to investigate the range of transfer.

To evaluate the success of training, various transfer standards can be used. Researchers think differently about this matter. There is a standard for transfer of training commonly used in Europe which progresses from less to more stringent criteria (Tomic, Kingma, & TenVergert, 1993).

The magnitude of the training effect reflects a broad near-far transfer, because in an untrained concept area (intelligence tasks) transfer occurred. The training program also induced a far-far transfer in arithmetic. Since arithmetic tasks were not part of the training program, this is a noteworthy result. From an educational psychology point of view, a training effect which is observable for at least four months and an induced near-far and far-far transfer are considered sufficient evidence of training effectiveness (Tomic, et al., 1993). Such a training effect implies the durability of childrens' inductive reasoning skills. By giving children a wide range of tasks to perform after being trained, the results show that training has resulted in a transferable action structure. Noteworthy as well is that the arithmatic scores of the experimental group are significantly higher than the control group arithmetic scores. This finding indicates that the trained children benefited more from regular education than their control group counterparts.

The question remains why the training program induced a wide range of transfer, i.e. far-far transfer. From the literature it is known that the likelihood of transfer can be increased by building certain techniques into the training program's design (Garavaglia, 1993). A possible explanation for far-far transfer as it occurred in the present study might be that, first, the training program uses many different examples and presents them in various contexts in which children can expect to use the skills and knowledge learned in training. Second, the program consists of many analogies which also help increase transfer. Third, the training program helps to increase transfer by showing how inductive reasoning principles can apply in various situations. Fourth, transfer tends to be better when learners understand the general principles behind the skills they are learning. Children are encouraged to discover the general principles in the training tasks. By giving children a broader, deeper knowledge and more tools for problem solving, the likelihood of understanding those principles increases; neophytes can turn into experts (Goldstein & Musicante, 1985). Finally, transfer is more likely to occur when identical elements appear in different test situations. Tasks taught in training to children closely match the tasks children do in the posttests.

Although the results of our study confirmed the earlier findings of Klauer (1992), and Phye and Sanders (1993), our study deviates in some important respects. The training was administered in a different educational system. The experimental and control groups consisted of children from various ethnic backgrounds. The trainers were very briefly instructed in the program. Unlike the designer of the training program, who has had very experienced staff members administer training in his own research, training in this experiment was provided by trainers who had very limited experience in instructing young children. The experimental group received fewer training sessions than Klauer is used to utilizing. The concept of feedback was emphasized during training. The study used far-far transfer as a measure for whether cognitive representation had changed by implementing the training program.

In view of the abovementioned points, it can be concluded that the results of our study strengthen the findings of Klauer (1992), and Phye and Sanders (1993), with the additional evidence of transfer durability. These results also demonstrate that inductive reasoning training can have a significant educational impact when conducted in the context of regular schools with average intelligence children. It is recommended to apply the training program in a regular primary education curriculum.

Although the mean score of the experimental group is significantly higher than the mean score of the control group, Table 1 shows that the control group children also showed a slight progress in intelligence and arithmetic tasks. The time interval between the pretest and the first posttest was about four weeks; the second posttest was administered five months after the pretest. This might explain the small increase in intelligence and arithmetic scores for these control group children during that period. This merely represents the "normal" acquisition rate of the three tasks. First, this result corresponds to similar research (Kingma, 1986; Tomic, et al., 1993). Second, the educational and developmental psychology literature have made clear that children of about 7 years acquire a relatively large amount of knowledge and relatively large number of skills in a quite restricted time span (Woolfolk, 1995). Third, from early youth to the sixteenth year of life the raw score of an intelligence test increases; the scores of the experimental group increased more than the scores of the control group.

Although a number of researchers consider the requirement set by both Piaget and Galperin for far-far transfer too stringent, in the present study the effects of the intervention based on Klauer's (1989c) inductive reasoning training program fulfilled this requirement. The results indicate that training provided according to the description given above can have a significant educational impact when conducted in the context of regular schools with average intelligence children.

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TABLE 1

A Survey of the Mean Total Near-Far and Far-Far Transfer Scores and Standard Deviations for Both Training and Control Groups on Immediate and Delayed Transfer Tasks.

		Task			
		Raven Coloured Progressive Matrices Test*		Arithmetic**	
Posttest	Condition	(near-far transfer)		(far-far transfer)	
Immediate	Training	9.7	1.4	13.1	3.3
	Control	8.7	1.6	11.5	3.5
Delayed	Training	9.9	1.1	14.8	3.1
	Control	9.3	1.3	13.1	3.8

Note. *: Maximum score was 12. **: Maximum score was 20.

Figure Captures

Figure 1: Sample items of the math test

Figure 2: Sample items of the training program

FIGURE 1

Fill in the correct numbers

```
 ___     ___     ___
|___| + |___| = |___|  |   9   5   4
 ___     ___     ___   |
|___| > |___| > |___|  |  16  14  20
 ___     ___     ___   |
|___| - |___| = |___|  |  17   3  20
```

One of the numbers on the right also belongs to the set in the circle

```
      ............        |
    .      10       .     |
  .   50         30    .  |  21  33  20  17
    .      40       .     |
      .............       |
```

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