THE TRANSCENDENTAL MEDITATION TECHNIQUE, WORKING MEMORY, AND FIELD INDEPENDENCE IN SCHOOL-AGED CHILDREN

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The Transcendental Meditation programme was found to improve working memory in school children.—EDITORS

The effect of the Transcendental Meditation (TM) technique on working memory and field independence was investigated in a twelve-week longitudinal time-series study in which the "Match Me" computerized memory game and the Rod and Frame Test were administered daily to a matched pair of 11-year-old boys and a matched pair of 14-year-old girls. One of the boys and one of the girls began the TM technique after six weeks. The data were analyzed by factorial ANOVAs, which were appropriate because of absence of time-series autocorrelations or correlations between factors. The predicted improvement among experimental subjects in contrast to controls was found for the memory task and, for the younger male subjects, on the field independence measure. Experimental and control older female subjects both increased in field independence as a result of repeated measurement.

The purpose of the present research was to investigate the influence of a mental practice, the Transcendental Meditation (TM) technique, on two cognitive factors related to the learning process—efficiency of short-term or "working" memory and field independence. The effective functioning of short-term memory plays an ubiquitous role in the processing of information; for example, inefficient working memory has been related to reading disability (Lovegrove and Brown, 1978) and to educational underachievement (Sugden, 1978). Children with high field independence have been found to make greater use of preexisting knowledge schemata (Spiro and Tirre, 1980), to perform better on reasoning tasks (Boss and Amin, 1978), to display greater transfer of training for tasks involving complex stimuli, and to learn more effectively in the absence of extrinsic rewards (Goodenough, 1976).

These two variables have also been found to be related; greater field independence is associated with more efficient functioning of short-term memory under conditions of high information load (Robinson and Bennink, 1978). Each of these two variables reflects the ability to focus attention and avoid distraction; therefore the training of attentional processes involved in meditation might affect these capabilities.

The Transcendental Meditation technique is defined as "turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of a thought and arrives at the source of thought" (Maharishi Mahesh Yogi, 1969, p. 470). This experience is predicted to enhance the ability to focus attention outside of meditation while maintaining a broad internal frame of reference.
Previous research on college students employing longitudinal designs with random assignment to groups has found improvement in the efficiency of short-term memory and increased field independence after subjects began the Transcendental Meditation technique. Miskiman (1977) found, after 40 days, an increase in clustering in short-term recall among subjects who began the Transcendental Meditation technique in contrast to controls on a task in which subjects had to recall lists of words after either two-, four-, or six-minute intervals in which they performed an arithmetic filler task. Pelletier (1974) found an increase in field independence after three months on both the Rod and Frame Test and the Embedded Figures Test among subjects who were instructed in the Transcendental Meditation technique.

The present study assesses the influence of the Transcendental Meditation technique both on the efficiency of working memory and on field independence among school-age children. It is a small-sample study employing methods taken from time-series analysis. It was hypothesized that, in contrast to controls, experimental subjects would display increased efficiency of short-term memory and greater field independence following instruction in the Transcendental Meditation technique.

METHOD

SUBJECTS—Subjects in the study were four New Jersey children, two boys age 11 and two girls age 14. One boy and one girl (siblings) served as experimental subjects who began the Transcendental Meditation program, and the other pair, also siblings and school friends of the first pair, served as controls. The experimental subjects were selected because they were planning to begin the Transcendental Meditation technique and were willing to give the extensive amount of time required for repeated measurement. Control subjects were matched by age and sex, and the fact that they were also siblings, friends of the first pair, and willing to participate for the required amount of time. In order to sustain motivation, the experimenter took the subjects on an outing every two weeks, to the movies, beach, etc.

APPARATUS—The short-term memory task employed was a computerized children's game entitled "Match Me", produced by Kingsford Ltd. The game has a circular display board with eight light-illuminating colored lenses around the outer perimeter of the board. When the game begins one of the lenses is illuminated, which the subject presses. Then that light is again illuminated, followed by another light; the subject must remember and press this sequence of colored lenses. The game continues with the sequence getting longer after each correct trial, and with the presentation speed of the machine's light sequence increasing. A different tone is also heard with each light. The game terminates with an incorrect response sequence or when longer than 10 seconds elapses between any choice in the subject's response sequence. A "buzz" is heard at the improper termination of a response sequence. If an incorrect response sequence is not given, the end of the game is a sequence of 16 lights after which a musical signal comes on to inform the child that he or she has reached the limit of the machine.

The measure of field independence was the Rod and Frame Test. For a complete description of this apparatus see Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner (1954).

PROCEDURE—Each subject was tested daily on the two measures (Monday through Saturday) for 12 weeks, with occasional days without testing if necessary. The two experimental subjects were given standard instruction in the Transcendental Meditation technique after six weeks, which they practiced for 10 – 15 minutes twice daily. In each daily testing session the two male subjects were yoked together, tested at the same time of day (noon), as were the two female subjects, who were tested in the morning. The testing time for the girls had to be rescheduled in the afternoon for the last fourteen sessions. Within each pair, there was daily alternation of which person was tested first. Each child was tested alone.

On the memory task, each child was given three trials of the task per session. After each trial of the task, upon hearing the sound which signaled an improper response sequence, a button was pressed which replayed the correct sequence. The experimenter and subject then counted the number of items in the prior sequence which had been correctly matched; this button was pressed as many times as needed for agreement between the two, and the experimenter recorded this number. The mean of the three trials for each session was the score for that session.
For the Rod and Frame Test, subjects were seated seven feet from the illuminated rod and frame in a completely darkened room. Six trials of the test were administered at each session, two sitting erect in a chair, and four seated on a platform which was angled 28° either right or left. Subjects also sat with the head in a head rest at the given angle. Each day they alternated between sitting erect first or being first at an angle; the seating angle (left or right) was also alternated each day but not changed within the session. The initial angle of the rod and frame was randomly set. Mean deviation from 0° (vertical) was recorded at the day’s score. Because of a marked practice effect with one child, beginning on the fourth day the subjects were asked on alternate days to align the rod to true horizontal, in which case the mean deviation from 90° for the three trials was recorded.

Because of the marked practice effect on the Rod and Frame Test during the first few days for the female control subject, the first five sessions were omitted in the analysis of the girls’ performance; after this time all observations were within three standard deviations of the mean. The first session of this test was excluded from analysis for the boys, because the control subject misunderstood the instructions. There was no evidence of a practice effect on early trials of the memory task. After omitting these trials, the boys were tested 33 times on the Rod and Frame Test before the Transcendental Meditation technique instruction, while the girls were tested 28 times; after this, the boys were tested 34 times and the girls 33 times. The boy subjects were tested 36 times on the memory test, and the girl subjects 34 times, before beginning the Transcendental Meditation technique; all subjects were tested 34 times afterwards.

RESULTS

The results supported the hypothesis for the memory task, while for the Rod and Frame Test it was supported only for the younger (male) subjects.

The first step in data analysis for this time-series design was to assess the time-dependent structure of the pre-intervention data of each of the four subjects on each measure. An auto-regressive integrated moving averages (ARIMA) analysis was performed (Box and Jenkins, 1970; Glass, Willson, and Gottman, 1975); with one exception, the baseline time-series for all four subjects on both tasks was specified by an ARIMA \((0, 0, 0)\) model (“Gaussian white noise”). This indicates no time-dependent predictability, i.e., that the data points in each time-series are statistically independent. The exception was the Rod and Frame data for the 14-year-old girl experimental subject, which were specified by an ARIMA \((0, 0, 1)\) model for the baseline period. To make this subject’s data points statistically independent, so that the same data analysis procedures could be performed for all subjects, this model was used to predict pre- and post-intervention data, and the residuals, which were ARIMA \((0, 0, 0)\), were substituted for the raw data, after adding a constant to bring the pre-intervention mean to its original value. The post-intervention data for all subjects on both tasks was ARIMA \((0, 0, 0)\).

For a time-series which is ARIMA \((0, 0, 0)\), the pre- and post-intervention data may be compared by a t-test for independent samples (Glass et al., 1975). Similarly, if a yoked control subject is also measured, and the two time-series are each ARIMA \((0, 0, 0)\) and not cross-correlated, then the data may be analyzed by a two factor ANOVA*. For the present data, correlations were run between all six possible pairs of the four subjects for the pre-intervention time-series and for the post-intervention time-series for both measures. Of these 24 correlations, only one reached the .05 significance level, which would be expected by chance. Thus, it is appropriate to analyze this data by a two (groups—experimental and control) by two (sex—boy and girl; or age—11 and 14) by two (intervention—pre and post) factorial ANOVA. All factors are between-subject factors, including the intervention factor, because of the statistical independence of the data points. The major hypothesis predicts an intervention effect among the experimental subjects, or a significant group by intervention interaction.

For the memory task, there was no significant three-factor interaction, and the predicted group by intervention interaction was found to be significant, \(F(1,268) = 8.52, p < .01, \omega^2 = .027\). Table 1 presents the cell means and standard deviations for this interaction. Tests of simple main effects indicate that the improvement in memory performance among experimental subjects was significant, \(F(1,136) = 31.67, p < .001, \omega^2 = .181\), while there was no significant

*Personal communication: Glass, G. V., 15 October 1980.
change for controls, \( F(1,136) = 1.89, p > .05 \). There were also significant main effects for each of the three factors, groups \( F(1,268) = 228.25, p < .001, \omega^2 = .456 \), age or sex, \( F(1,268) = 199.42, p < .001, \omega^2 = .423 \), and intervention, \( F(1,268) = 45.31, p < .001, \omega^2 = .140 \). These main effects indicate that the experimental subjects had higher scores than the controls, that the 11-year-old boys performed better than the older girls, and that post-intervention performance was better than pre-intervention performance. A significant interaction of group with the age or sex factor, \( F(1,268) = 21.01, p < .001, \omega^2 = .069 \), reflects the fact that the difference between experimentals and controls was greater among the older girls than the younger boys. An additional significant interaction of intervention with the age or sex factor, \( F(1,268) = 3.90, p < .05, \omega^2 = .011 \), indicates that the increase from pre- to post-intervention was greater among the younger boys than the older girls.

For the Rod and Frame Test, the meaningfulness of the predicted interaction of group and intervention was superseded by a significant three-factor interaction, \( F(1,248) = 5.53, p < .05, \omega^2 = .018 \). This significant interaction was probed by performing simple interactions of groups and intervention separately for the younger boys and older girls. For the younger boys, this interaction was significant, \( F(1,130) = 4.24, p < .05, \omega^2 = .024 \). For the older girls it was not, \( F(1,118) = 2.12, p > .05 \), although there was a significant main effect for intervention, \( F(1,118) = 10.27, p < .01, \omega^2 = .071 \), with post-intervention performance higher. The significant interaction for the younger boys reflected a significant improvement in performance for the experimental subject, \( F(1,65) = 22.02, p < .001, \omega^2 = .236 \), and no significant change for the control subject, \( F(1,65) < 1 \). Cell means and standard deviations for this interaction are given in table 2. Three significant main effects in the overall ANOVA were also found, for groups, \( F(1,248) = 43.35, p < .001, \omega^2 = .144 \), for age or sex, \( F(1,248) = 160.70, p < .001, \omega^2 = .389 \), and for intervention, \( F(1,248) = 19.24, p < .001, \omega^2 = .068 \). These effects indicate that, independent of other factors, experimental subjects performed better than controls, younger males performed better than older females, and subjects performed better after the intervention than before. None of the two-factor interactions in the overall ANOVA were significant.

### TABLE 1

<table>
<thead>
<tr>
<th>GROUP</th>
<th>N*</th>
<th>PRE-INTERVENTION</th>
<th>POST-INTERVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td>Experimental</td>
<td>70(68)</td>
<td>9.74 2.61</td>
<td>12.05 2.19</td>
</tr>
<tr>
<td>Control</td>
<td>70(68)</td>
<td>7.40 2.55</td>
<td>8.02 2.79</td>
</tr>
</tbody>
</table>

* Total number of observations in pre-intervention time-series for male and female subjects combined are listed. Numbers in parentheses indicate the total observations in the post-intervention time-series.

Group by intervention interaction \( p < .01 \) (ANOVA)

Simple main effects \( p < .001 \) for TM subjects; NS for controls, (pre–post)

### DISCUSSION

The hypothesis of the study was supported by the memory task, but only for the younger (boy) subjects on the field independence measure. For the older (girl) subjects, there was a practice effect on the field independence test as a result of which both experimental and control subjects improved.

The improvement in memory performance might be attributed to several factors. One possibility is that the effect is simply due to an improvement in short-term memory. However, since, among adults, the capacity of short-term memory is constant, at approximately seven items (Miller, 1956), this seems unlikely. Because the experimental subjects averaged a correct series of 12 lights after beginning the Transcendental Meditation technique, other factors are probably involved. One explanation of how the subjects could perform so well, indicated by an examination of the task, is that the measure requires the child to respond to a series which increases only by one item each trial. That is, when the series is at ten items, the subject has practiced the first item nine times, the sequence of the first two items eight times, the first three items seven times, etc. Thus, the child is able to practice a visual motor sequence which allows him or her to "unitize" or "chunk" parts of the sequence, and the memory demand is
not as great as it might seem. Another factor which contributes to performance is clearly the ability of the child to attend consistently to the task. So the improvement found on the memory task may be due to improvements in attention and efficiency of encoding a visual-motor pattern.

The significant main effect for group raises the question of the comparability of the control subjects. Although the experimental and control subjects were matched for age, sex, and motivation, the experimental subjects performed better on both tasks than control subjects even before they began the Transcendental Meditation technique. The significant interaction of group and the age or sex factor is due to the poorer level of performance of the control 14-year-old girl on the memory task; as a result, the difference between experimental and control performance on this measure was greater for the older girls. It is obvious that the small sample size makes individual differences contribute to a significant main effect of the group variable. Given this situation, cross-validational research is in order to strengthen the external validity of the major findings.

The significant main effects of age or sex on both measures reflected better performance by the sample of 11-year-old boys. Since both field independence (Pierce, 1980) and working memory (Saraswathi, 1976) increase with age, this difference does not appear to be due to age. Field independence in commonly higher among males (Hulfish, 1978), but since the same difference was also found on the memory task, this difference in performance might also be attributable simply to individual differences in the small sample.

The results of this study indicate that the Transcendental Meditation technique can have a positive effect on the efficiency of working memory and perhaps on field independence (as found here for the younger boy subject) over a six-week period among school-age children. The replication of these results would provide strong incentive to apply the Transcendental Meditation program to school settings and measure its effects on learning outcomes affected by these variables.

REFERENCES


