Journal of Autism and Developmental Disorders, Vol. 10, No. 4, 1980

Decreasing Self-Stimulatory Behavior with Physical Exercise in a Group of Autistic Boys[1]

Robert G. Watters
University of Ottawa

Wilhelmina E. Watters
M. F. McHugh School, Ottawa

Five autistic boys were observed during 27 language training sessions. Each session followed one of three periods: (a) physical exercise, (b) TV watching, or (c) regular academic work. It was found that (a) the lowest levels of self-stimulation followed physical exercise, (b) there were no differences in the levels of self-stimulation following TV watching and following academics, and (c) the levels of correct question answering were not affected by the three different previous periods.

Self-stimulatory behaviors such as rocking, hand flapping, mouthing, and spinning objects are a defining characteristic of autistic children (Rimland, 1964). Reinforcement of incompatible behavior (Luiselli, Helfen, Pemberton, & Reisman, 1977; Mulhern & Baumeister, 1969), overcorrection (Azrin, Kaplan, & Foxx, 1973; Foxx & Azrin, 1973; Freeman, Moss, Somerset, & Ritvo, 1977; Luiselli et al., 1977; Wells, Forehand, Hickey, & Green, 1977), punishment (Baroff & Tate, 1968; Lovaas, Schaeffer, & Simmons, 1965; Risley, 1968; Tate & Baroff, 1966), and time-out (MacDonough & Forehand, 1973; White, Nielson, & Johnson, 1972) are among the behavioral techniques that have been applied to an elimination of self-stimulatory behaviors.

[1]We wish to thank Dora VanStrepen, Alison Lennox, John Rager, Bill Sharkey, and Sheila Connolly for their cooperation and assistance, and Gordon McClure, principal, for providing an environment nurturant to research as well as to children and teachers.

0162-3257/80/1200-0379$03.00/0

The second author, who teaches autistic children and is familiar with these procedures, noted anecdotally that there seemed to be a decrease in self-stimulatory behavior following gym periods, field trips, and outside excursions. Such an effect, if substantiated, might provide yet another technique for controlling self-stimulatory behavior. However, if the decrease in self-stimulation was accompanied by a general decrease in other behaviors, the technique would be of relatively little use. It was decided, therefore, to assess the effect of exercise on a simple academic performance as well as on self-stimulatory behaviors. To control for the possibility that any observed effects were due simply to a change from the usual academic routine, a second comparison condition (TV watching) was included.

The purpose of the study was, then, to assess the effects of physical exercise on the self-stimulatory behavior of autistic children. This assessment was carried out by monitoring the self-stimulatory behavior and academic performance of a small group of autistic children during a language training session, which was arranged to follow regular academic activity, TV watching, or a period of physical exercise.

METHOD

Subjects

All five subjects were male and had been diagnosed as autistic by agencies not associated with this study. They ranged in age from 9 years 5 months to 11 years 7 months when the study began, and all had been tested with the Stanford-Binet approximately 1 year before the study began. Each subject had several nonvocal self-stimulatory behaviors that were displayed if no attempt at control was exercised by a teacher. The characteristics of each subject are summarized in Table I.

A sixth and sometimes a seventh child participated in the sessions but no data were collected on these children as they did not display self-stimulatory behaviors.

Setting and Materials

The room where the language training sessions took place was a regular classroom approximately 4 by 5.3 m. The children sat on chairs in a row approximately 3 m long in a cleared area in the center of the room. A piece of cardboard (.7 m by .6 m) was placed on the floor approximately 1.7 m in front of the children. The observer was located at the side of the room

Table I. Subject Characteristics

Subject	IQ score	Age (years)	Self-stimulatory behaviors
A	34	11.6	Configuring fingers Rocking back and forth
B	73	9.5	Hand flapping Mouthing and biting hands Rocking back and forth
C	35	11.6	Configuring fingers Biting hands Rocking back and forth
D	48	10.2	Rocking back and forth
E	39	9.4	Hand flapping Tapping fingers against things Rocking back and forth

and in front of the children, and the teacher not conducting the language training session was located at the other side, also in front of the children.

The picture cards used in the language training sessions were 13 cm by 16.5 cm and were selected from the Language Rehabilitation Program (Hain & Lainer, 1977). A selection of these cards (five or nine) was arranged in a random array on the cardboard on the floor. Each card showed a colored picture representing a descriptive sentence. The cards selected were known to the children, and under optimal conditions they would be expected to do well on the auditory-visual matching task with these cards.

Observation Scheme

The observer rated the children using a 5-second observe/5-second record sampling scheme. The order for observing the children was determined by reference to a randomized sequence. The first 5-second observation interval was directed at the first child, the second 5-second interval at the second child, and so on, until all children had been observed; then the cycle was repeated. Observing and recording continued until the language training session ended. Session length varied from 8 to 13 observation intervals per child (mean = 10.8). During each observation interval, self-stimulatory behavior was monitored. Self-stimulatory behavior was individually defined for each child as the occurrence of any of the behaviors listed for that child in Table I.

A second teacher, not directly involved in the language training session, monitored each child's answers during the language training. Children were asked between three and six questions per session (mean = 4.9). A correct answer was defined as choosing the correct choice card in the auditory-visual matching task that constituted the language training.

Preconditions

The academic precondition represented the variety of typical academic periods to be found in the school. They ranged from group activities to intensive one-to-one training. No attempt was made to control the duration or content of these periods as this precondition was intended to represent the accumulated recent experience of the child midway through a typical school day.

The TV precondition consisted of seating the children in front of a TV set. The teachers ensured that they remained in their seats but did not control where they looked. These sessions were of 10- to 15-minute duration and the program was always "Sesame Street."

The physical exercise precondition consisted of jogging with the children in the schoolyard for 8 to 10 minutes. Initially, the teachers had to "drag" some of the children along, but by the end of the study the children were jogging along with the teachers with minimal prompting.

During the three preconditions the teachers exerted normal control over the children, including control over self-stimulatory behaviors.

The TV precondition was included as a check for the possibility that any postexercise behavior change would be due to a change from the normal academic routine rather than to exercise per se. If there were changes in behavior following the TV precondition that were similar to changes following the exercise precondition, then it would not be reasonable to attribute the postexercise changes to the exercise. However, it was hard to justify the TV precondition for the school curriculum as it was not part of the regular academic routine for these children. Consequently, the TV precondition was not included throughout the study but was included for five sessions only, the minimum considered necessary to serve as a control function.

There were 5 TV preconditions, 11 academic preconditions, and 11 physical exercise preconditions, for a total of 27 sessions. The first 15 sessions were 5 TV, 5 academic, and 5 physical exercise sessions in randomized order. The remaining 12 were 6 academic and 6 physical exercise sessions in randomized order. There were from 1 to 4 sessions a week with no more than 1 session per day.

During 19 of the 27 sessions a second observer recorded self-stimulatory behavior, and during 19 sessions both teachers conducting the session recorded correct answers. For self-stimulation, reliability for a session was calculated by dividing the number of observation intervals that had observer agreement by the total number of observation intervals and multiplying by 100. Session reliabilities ranged from 82.5% to 100.0%, with a mean of 95.5%. For correct answers reliability for a session was calcu-

lated by dividing the number of answers that had observer agreement by the total number of questions asked during the session and multiplying by 100. Session reliabilities ranged from 92.0% to 100%, with a mean of 99.1%.

Procedure

The children participated as a group in the language training sessions. The preconditions and language training sessions were conducted by the regular teachers with the assistance of a psychology undergraduate.

Upon completion of the precondition the children were brought to the classroom for the language training session. During this session the teachers made no attempt to control the children's self-stimulatory behaviors.

The general form of the language training was that of auditory-visual matching-to-sample, with which the children were familiar. The teacher said, "I want someone to touch the picture fo X. [Child's name], you touch X." X was a sentence describing the correct choice card. The child named was then expected to leave his seat, go to the cardboard on the floor, and touch the appropriate card from among the array of five picture cards. Correct responses were followed by a verbal reinforcer (e.g., "good"), then by a primary reinforcer (food). Following incorrect responses the child was guided to make the correct response and was then verbally reinforced.

The order in which the children were asked questions was determined by reference to a random sequence. Five to seven times during each session the picture cards were removed and a new set was arrayed on the cardboard. At the end of the language training session the children were returned to their regular routines.

RESULTS

Each child's self-stimulation data for a session represented the number of intervals during which the child was observed to self-stimulate and the total number of observation intervals. The child's data for sessions following the academic precondition were added together and converted to a percentage. Similarly, for each child the data for sessions following the exercise precondition and the TV precondition were converted to percentages.

Each child's correct answer data for a session represented the number of questions asked of the child during the session and the number of correct answers given by the child. The child's data for sessions following the academic precondition were added together and converted to a percentage, as were data for sessions following the exercise and TV preconditions.

Table II. Percentage of Self-Stimulation

Subject	Academic precondition	Physical exercise precondition
A	59.5	28.6
B	25.9	15.6
C	25.0	22.3
D	48.3	20.7
E	76.3	73.5

After the first 15 sessions, the percentage of self-stimulation for each child following the 5 TV precondition sessions was compared with the percentage of self-stimulation following the first 5 academic precondition sessions. There were no consistent differences across subjects and a Randomization Test for matched pairs (Siegel, 1956) with $\alpha = .05$ and a two-tailed region of rejection found no statistically significant difference. A similar comparison of the percentage of correct answers for each child following the TV precondition with the percentage of correct answers following the first 5 academic precondition sessions found no statistically significant difference.

Table II presents, for the entire study, the self-stimulation percentages for each child following the academic and the physical exercise preconditions. For all subjects there was a decrease in self-stimulation following the exercise precondition. This decrease expressed as a percentage of the level following the academic precondition ranged from a 3.7% decrease for Subject E to a 57.1% decrease for Subject D, with a mean reduction for all subjects of 32.7%. A randomization test for matched pairs (Siegel, 1956) with $\alpha = .05$ and a one-tailed region of rejection indicated that the observed reduction following the physical exercise precondition was statistically significant.

The percentage of correct answer data for the whole study, presented in Table III, does not show any consistent difference across subjects in the level of correct answers following the academic and the exercise precondi-

Table III. Percentage of Correct Answers

Subject	Academic precondition	Physical exercise precondition
A	88.7	78.0
B	94.3	98.2
C	70.4	56.0
D	94.3	92.9
E	58.5	77.8

tions. A randomization test for matched pairs (Siegel, 1956) with $\alpha = .05$ and a two-tailed region of rejection found no statistically significant difference in the level of correct question answering following the academic and exercise preconditions.

DISCUSSION

To summarize, the results indicate that (a) there is a decrease in self-stimulation following the physical exercise precondition as compared to the level of self-stimulation following the regular academic precondition, and (b) the levels of correct answering are not different following physical exercise and academics. The lack of a difference in the levels of self-stimulation and question answering following TV watching and academics supports the contention that the decrease in self-stimulation following exercise is due to the exercise rather than to the change from the normal academic routine.

The first finding confirms the anecdotal observation that prompted the study. There is less self-stimulatory behavior following periods of physical exercise and this decrease of 32.7% (on the average) was judged to be a useful reduction by the teachers of these children. The fact that the decrease in self-stimulatory behavior is not accompanied by a decrease in the critical behavior of answering questions correctly means that exercising children is a potentially useful procedure for decreasing self-stimulation.

In addition to the potential health benefit to the child, the physical exercise procedure has two useful characteristics. First, unlike the usual applications of time-out, overcorrection, punishment, and the reinforcement of incompatible behaviors, the physical exercise intervention occurred before the language training session. Thus the procedure did not interrupt the classroom teaching program. Second, the procedure is relatively undemanding of a teacher's behavior management skills. Holding a child's hand while he jogs across a field requires less preparatory training than does properly administering other behavioral procedures.

A number of questions arise from these results. One concerns the effect of longer or more intensive exercise periods; the present results were obtained with only 8 to 10 minutes of jogging. Another question is about the effect of the physical exercise precondition on a learning task. The task chosen for use in the present study was known to the children and the sessions are best conceptualized as review sessions. The learning of a new task by the children might be influenced differently by the exercise precondition. A third question concerns the role of overlap between the self-stimulatory behavior, the academic task, and the physical exercise.

Self-stimulation, academic tasks, and physical exercise all involve certain responses. In the present study the self-stimulatory behaviors (see Table I) involved finger, hand, arm, mouth, and torso movement. The academic task involved listening, looking, getting up from a chair, walking, bending, and reaching. There was, then, some overlap between the self-stimulation and the academic task (e.g., for some children both involved arm movements), but there were also areas of no overlap (e.g., none of the self-stimulatory behaviors involved looking or walking). The overlap between self-stimulatory behaviors and task requirements has received some attention (Klier & Harris, 1977; Koegel & Covert, 1972; Koegel, Firestone, Kramme, & Dunlap, 1974). A suggestion in this literature is that the greater the degree of overlap, the more the self-stimulatory behavior interferes with the task and the greater is the facilitation of task performance when the self-stimulatory behavior is eliminated. In the present study, the physical exercise precondition resulted in a decrease in self-stimulation with no improvement in task performance. These results might be due to the rather minimal overlap between the self-stimulatory behaviors and the task. For tasks with a greater overlap, the physical exercise precondition might have a facilitating effect on task performance.

The physical exercise of jogging involves leg, arm, and some torso movement. There was, then, some overlap between the exercise and the self-stimulatory behaviors (e.g., for some children the self-stimulation involved arm movement and jogging involved arm movement), but there were also areas of no overlap (e.g., none of the self-stimulatory behaviors involved leg movement). The massed practice or negative practice procedure (Yates, 1970) resembles closely the use of physical exercise to decrease self-stimulatory behaviors in the present study. The procedure proposes to eliminate a behavior by having the patient repeatedly perform the behavior. This exercise is to take place without a break. The major use of the procedure has been to eliminate tics (Jones, 1960; Rafi, 1962; Walton, 1964; Yates, 1958), stuttering (Case, 1960; Yates, 1970), and head banging (Wooden, 1974). The success of the procedure suggests that the greater the overlap between the behavior practiced and the behavior to be eliminated, the greater will be the effect. In the present study, physical exercises chosen to fit each self-stimulatory behavior might have an increased effectiveness in eliminating the self-stimulatory behavior.

REFERENCES

Azrin, N. H., Kaplan, S. J., & Foxx, R. M. Autism reversal: Eliminating stereotyped self-stimulation of retarded individuals. *American Journal of Mental Deficiency,* 1973, *78,* 241-248.

Baroff, G. S., & Tate, B. G. The use of aversive stimulation in the treatment of chronic self-injurious behavior. *Journal of the American Academy of Child Psychiatry,* 1968, *7,* 454-470.

Case, H. W. Therapeutic methods in stuttering and speech blocking. In H. J. Eysenck (Ed.), *Behavior therapy and the neuroses.* Oxford: Pergamon, 1960.

Foxx, R. M., & Azrin, N. H. The elimination of autistic self-stimulatory behavior by over-correction. *Journal of Applied Behavior Analysis,* 1973, *6,* 1-14.

Freeman, B. J., Moss, D., Somerset, T., & Ritvo, E. R. Thumbsucking in an autistic child overcome by overcorrelation. *Journal of Behavior Therapy and Experimental Psychiatry,* 1977, *8,* 211-212.

Hain, R., & Lainer, H. *Language rehabilitation program.* New York: Teaching Resources, 1977.

Jones, H. G. Continuation of Yates' treatment of tigueur. In H. J. Eysenck (Ed.), *Behavior therapy and the neuroses.* Oxford: Pergamon, 1960.

Klier, J., & Harris, S. L. Self-stimulation and learning in autistic children: Physical or functional incompatibility? *Journal of Applied Behavior Analysis,* 1977, *10,* 311.

Koegel, R. L., & Covert, A. The relationship of self-stimulation to learning in autistic children. *Journal of Applied Behavior Analysis,* 1972, *5,* 381-387.

Koegel, R. L., Firestone, P. B., Kramme, K. W., & Dunlap, G. Increasing spontaneous play by suppressing self-stimulation in autistic children. *Journal of Applied Behavior Analysis,* 1974, *7,* 521-528.

Lovaas, O. I., Schaeffer, B., & Simmons, J. Q. Building social behavior in austistic children by use of electric shock. *Journal of Experimental Research in Personality,* 1965, *1,* 99-109.

Luiselli, J. K., Helfen, C. S., Pemberton, B. W., & Reisman, J. The elimination of a child's in-class masturbation by over correction and reinforcement. *Journal of Behavior Therapy and Experimental Psychiatry,* 1977, *8,* 201-204.

MacDonough, T. S., & Forehand, R. Response-contingent time out: Important parameters in behavior modification with children. *Journal of Behavior Therapy and Experimental Psychiatry,* 1973, *4,* 231-236.

Mulhern, T., & Baumeister, A. A. An experimental attempt to reduce stereotypy by reinforcement procedures. *American Journal of Mental Deficiency,* 1969, *74,* 69-74.

Rafi, A. A. Learning theory and the treatment of tics. *Journal of Psychosomatic Research,* 1962, *6,* 71-76.

Rimland, B. *Infantile autism.* New York: Appleton-Century-Crofts, 1964.

Risley, T. R. The effects and side effects of punishing the autistic behaviors of a deviant child. *Journal of Applied Behavior Analysis,* 1968, *1,* 21-34.

Siegel, S. *Nonparametric statistics for the behavioral sciences.* New York: McGraw-Hill, 1956.

Tate, B. G., & Baroff, G. S. Aversive control of self-injurious behavior in a psychotic boy. *Behaviour Research and Therapy,* 1966, *4,* 281-287.

Walton, D. Massed practice and simultaneous reduction in drive level—further evidence of the efficacy of this approach to the treatment of tics. In H. J. Eysenck (Ed.), *Experiments in behavior therapy.* New York: Pergamon, 1964.

Wells, K. C., Forehand, R., Hickey, K., & Green, K. D. Effects of a procedure derived from the over correction principle on manipulated and nonmanipulated behaviors. *Journal of Applied Behavior Analysis.* 1977, *10,* 679-687.

White, G. D., Nielsen, G., & Johnson, S M. Timeout duration and the suppression of deviant behavior in children. *Journal of Applied Behavior Analysis,* 1972, *5,* 111-120.

Wooden, H. E. The use of negative practice to eliminate nocturnal head banging. *Journal of Behavior Therapy and Experimental Psychiatry,* 1974, *5,* 81-82.

Yates, A. J. The application of learning theory to the treatment of tics. *Journal of Abnormal and Social Psychology,* 1958, *56,* 175-182.

Yates, A. J. *Behavior therapy.* New York: Wiley, 1970.