

Targeting Early Antecedents to Prevent Tobacco Smoking: Findings From an Epidemiologically Based Randomized Field Trial

ABSTRACT

Sheppard G. Kellam, MD, and James C. Anthony, PhD

Objectives. This study examined whether interventions aimed at aggressive/disruptive classroom behavior and poor academic achievement would reduce the incidence of initiation of smoking.*

Methods. An epidemiologically based, universal randomized preventive trial involved 2311 children in 2 classroom-based preventive interventions or controls. Each intervention was directed at 1 of the aforementioned 2 antecedents over first and second grades in 19 urban schools.

Results. Smoking initiation was reduced in both cohorts for boys assigned to the behavioral intervention.

Conclusions. Targeting early risk antecedents such as aggressive behavior appears to be an important smoking prevention strategy. (*Am J Public Health*. 1998;88:1490-1495)

Thousands of young people start smoking every day; an estimated one third will become tobacco dependent.¹ One way to prevent this may be to change early antecedents of smoking identified through developmental epidemiological studies.²⁻⁴ Among boys especially, aggressive/disruptive classroom behavior (in the form of breaking rules and fighting), as early as first grade, has been found repeatedly to predict later tobacco and other heavy drug use, as well as antisocial behavior and criminality.⁵⁻¹² Poor academic achievement, found to be correlated early on with aggressive behavior, has been shown to predict depression and, in some studies, drug use.^{8,9,13-16} In this study, 2 classroom-based interventions were each directed at 1 of these 2 early antecedents. We sought to test whether either intervention would reduce the incidence of initiating tobacco use, particularly among boys.

Methods

Interventions

The Good Behavior Game, a behavior management strategy designed to improve aggressive/disruptive classroom behavior, is led by the teacher during regular class periods.^{16,17} After baseline assessments of target behaviors, teachers assign all students to 1 of 3 teams, balancing teams for sex and levels of aggressive behavior. The teacher defines and posts undesirable behaviors. Examples are fighting, shouting out of turn, and teasing. Teams are rewarded when no member exhibits the proscribed behaviors during game sessions. If a child misbehaves, the team loses points. At first, tangible prizes are used, such as colorful stickers and erasers. Later in the school year, teachers use less tangible rewards. At first, the game was played for 10 minutes 3 times per week during the regular curriculum, with the fre-

quency and length of sessions increasing over first and second grades. Rewards were given weekly; if each child behaved well, all teams could win.^{17,18}

Mastery Learning, an enriched curriculum, was directed at raising reading achievement scores.^{17,19} Key elements were high expectations, small instructional units, use of formative testing, and individualized corrective methods. Students did not proceed to the next unit until 80% had achieved 80% to 85% of the learning objectives (instead of the usual 50%).^{17,18}

These classroom-based interventions were implemented for 2 years, in the first and second grades. We have previously reported evidence of Good Behavior Game impact on aggressive/disruptive behavior through sixth grade for boys who, at baseline, were above the median in terms of aggressive behavior.¹⁷⁻²² Improvements in reading scores with Mastery Learning were followed by reduced depressive symptoms over first grade, particularly among girls.¹⁹ Raising achievement scores accounted for reduced aggressive behavior, particularly among boys.²⁰

Study Population and Research Design

Five urban areas were defined with socioeconomic levels ranging from very poor to middle class.¹⁵ In each area, 3 to 4 public elementary schools with similar socioeconomic and racial/ethnic profiles were selected. Within each area, the Good Behavior Game

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was randomly assigned to 1 school and Mastery Learning to another; 1 or 2 schools were controls. Control classrooms received customary school programs. Within each intervention school, 1 first-grade classroom and teacher were assigned randomly to the intervention, and at least 1 classroom served as a within-school control. Within each school, all entering first graders were assigned in alphabetic sequence to classrooms. Over the 2 intervention years (first and second grades), classroom composition was kept intact. Transfers from one intervention to the other or from control to either intervention were rare, but in this study we adopted an intent to treat strategy, using initial assignment at baseline to define the intervention and control children. Protocols for this school-based investigation were approved by the Johns Hopkins School of Public Health institutional review board. Each child's parent/guardian was asked to give informed consent. During the first year of recruitment, only 5% declined to participate.²³

Two consecutive cohorts of first-grade children were recruited (total $n = 2311$), 1196 in cohort 1 (1985) and 1115 in cohort 2 (1986). A few children reported starting to smoke cigarettes prior to entry into first grade. Because they no longer were at risk for initiation, these children were excluded from the analytic sample. A total of 1604 children (cohort 1, $n = 818$ [68%]; cohort 2, $n = 786$ [70%]) initially still at risk remained in the Baltimore City Public Schools and completed an assessment of tobacco and other drug experiences on at least 1 occasion after intervention from 1989 until 1994. Ten students withdrew consent for follow-up assessments.²⁴ When attrition occurred, it was unrelated to intervention status ($P > .25$).

Among the 1604 children, 808 were boys and 796 were girls, and more than 90% had been born in either 1979 or 1980. About 22% were assigned to Good Behavior Game classrooms ($n = 352$), 22% were assigned to Mastery Learning classrooms ($n = 348$), and the rest were assigned to control classrooms ($n = 904$). A total of 502 youths (31.3% of the follow-up sample) were found to have initiated tobacco smoking when last assessed (Table 1).

Assessment Procedures

At the end of the first quarter of first grade, prior to implementation of the interventions, each teacher rated each child in the classroom in a standardized 2-hour interview using the Teacher Observation of Classroom Adaptation-Revised.^{25,26} This instrument's Authority Acceptance subscale gauges each child's level of aggressive/disruptive behav-

TABLE 1—Characteristics of Tobacco Users and Nonusers

	Tobacco Users ($n = 502$), No. (%)	Tobacco Nonusers ($n = 1102$), No. (%)	Total, No. (%)
Year of entry into 1st grade			
1985	275 (54.8)	543 (49.3)	818 (51.0)
1986	227 (45.2)	559 (50.7)	786 (49.0)
Sex			
Male	262 (52.2)	546 (49.5)	808 (50.4)
Female	240 (47.8)	556 (50.5)	796 (49.6)
Birth year			
1978	67 (13.4)	78 (7.1)	145 (9.0)
1979	230 (45.8)	511 (46.4)	741 (46.2)
1980	205 (40.8)	513 (46.5)	718 (44.8)
Design status			
Good Behavior Game	92 (18.3)	256 (23.2)	348 (21.7)
Mastery Learning	111 (22.1)	241 (21.9)	352 (21.9)
Standard setting	299 (59.6)	605 (54.9)	904 (56.4)

ior and includes items such as "fights," "breaks rules," and "harms property," each rated from 1 to 6 depending on frequency. The subscale's reliability has been adequate (Cronbach $\alpha > .85$ in the studies cited here); a robust association between first-grade ratings and adolescent drug use over 10 years has been reported.⁸ Research staff monitored fidelity of intervention implementation; no control classroom teachers used behavior management methods such as the Good Behavior Game or the Mastery Learning curriculum. Forty hours of instruction and support were provided to all teachers, including control classroom teachers.

Periodic meetings with school officials, community leaders, and parents led to community support for learning about children's drug experiences, but there was concern about saliva, breath, or urine testing. The accepted solution was annual face-to-face interviews 40 to 70 minutes in duration. These interviews were administered during the spring of each year from ages 8 and 9 through age 14. The interview was conducted in a private room in the school by a trained young adult interviewer. The interviewer first worked through issues of trust and rapport and read a disclosure statement that provided students with an opportunity to decline participation. The interviewer then read each standardized question and marked the student's responses. Each year, students were asked whether they had tried tobacco and their age at first use.^{8,24,27}

Statistical Analysis

We used standard life table and survival analysis methods to compare risk of initiating tobacco use for 2 interventions and all internal and external control classrooms. Kaplan-Meier²⁸ survival curves for each

group were compared via log-rank statistics as an aid to interpretation. Adjusted estimates for the relative risk of tobacco smoking also were obtained via conditional forms of Cox proportional hazards modeling; EGRET²⁹ was used in calculating estimates. To accommodate clustering of students within initial elementary schools, this analysis involved presorting of students into strata defined by school attended in first grade. Beyond accommodating the clustering of students, the Cox model³⁰ provided safeguards against the possibility that observed variations in smoking might be attributable to imbalances in the distribution of covariates (e.g., age, sex, level of aggression in first grade).

Results

Descriptive information about combined cohorts is provided in Table 1. Of the 1604 children who had not smoked at baseline, 502 had tried smoking by 14 years of age. Boys and girls were analyzed separately, considering the stronger attributable risk of aggressive behavior among boys. In each cohort, boys in Good Behavior Game classrooms were less likely than boys in control classrooms to initiate tobacco smoking (log rank $P = .03$). This was most apparent after 10 years of age. Figures 1 and 2 are plots of the male cohorts' cumulative incidence of tobacco smoking from 6 through 14 years of age. Girls in Good Behavior Game classrooms were not at lower risk (log rank $P = .55$).

Estimates from the Cox proportional hazards analyses were consistent with life table results. When grouped into risk sets defined at first-grade entry, boys in Good Behavior Game classrooms had a lower risk of starting to smoke than boys in control

Cohort: I

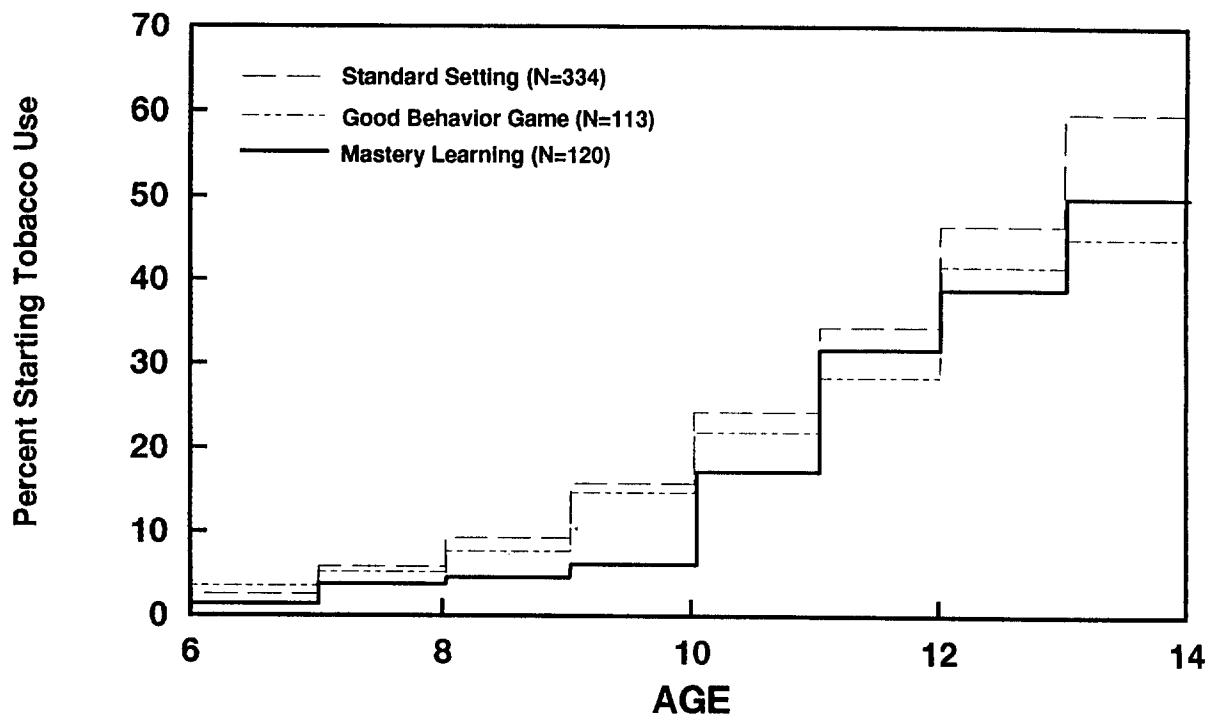


FIGURE 1—Impact of Mastery Learning and Good Behavior Game on boys in first and second grades in terms of initiation of tobacco smoking through 14 years of age: cohort 1.

classrooms (estimated relative risk [RR] = 0.62, 95% confidence interval [CI] = 0.40, 0.97; $P = .04$). The estimated risks for girls in Good Behavior Game and control classrooms were essentially the same (RR = 0.9, 95% CI = 0.57, 1.42; $P = .66$).

For girls in both cohorts, the Good Behavior Game appeared not to have affected risk of starting to smoke. In contrast, the relative risk estimates for boys in Good Behavior Game classrooms vs boys in control classrooms were 0.58 (95% CI = 0.33, 1.00) in cohort 1 and 0.62 (95% CI = 0.29, 1.31) in cohort 2. For boys in cohort 2 only, there was a statistically significant inverse association between assignment to Mastery Learning and risk of tobacco smoking (RR = 0.46, 95% CI = 0.24, 0.87; $P = .017$), although there was a similar trend in cohort 1.

In exploratory analyses of subgroup variation, both cohorts were grouped by gender and classified into tertiles by first-grade teacher's rating of aggressive/disruptive behavior; these analyses used the Cox models (Table 2). Boys in the best behaving tertile showed more impact, being much less likely to start smoking than control boys (RR = 0.13, 95% CI = 0.03, 0.62; $P = .01$). A congruent result emerged from corresponding comparative life table analyses of this subgroup of boys (log rank $P = .003$). We

found no Good Behavior Game impact at any level of aggressive/disruptive behavior among girls.

Discussion

In 2 consecutive cohorts, the estimated risk of initiating tobacco use was lower than expected for boys assigned to the Good Behavior Game intervention. The lack of impact of the Good Behavior Game for girls in these classrooms is consistent with the much lower risk for later drug use associated with aggressive/disruptive classroom behavior among girls. This result also supports the importance of early risk behaviors, which occur much more frequently among boys, in the etiology of teenage tobacco use.^{8,9,13-15,31}

Several caveats merit attention. First, this study focused on young people who remained in Baltimore public schools, an important and definable epidemiologic population and a majority of the original children. It did not include children who moved to other areas or transferred to private schools; these participants are now being followed up at 19 or 20 years of age. Outmigration from the school system was unrelated to intervention assignment. Second, our assessment of the youths' tobacco experi-

ences depended on self-report interview assessments made annually. Some researchers prefer to use bioassays to limit methodological problems associated with self report. However, we found that most youths recalled their first tobacco smoking experiences clearly. Furthermore, bioassays have questionable utility for assessing tobacco smoking across spans of 1 year or more. Self-report assessments have been central in basic studies linking early ratings of aggressive/disruptive behavior to later teenage smoking.⁸

Appearance of subgroup variation in response to interventions deserves attention, as discussed recently by Hatch.³² We have already commented on gender differences. We also found that boys at lower levels of aggressive/disruptive behavior in first grade seemed to benefit more, even though the Good Behavior Game had an impact among more aggressive boys in terms of later teenage aggressive behavior.²¹ This suggests that better-behaved children in Good Behavior Game classrooms were more able to withstand later exposure to tobacco and peer pressure than were their better-behaved control counterparts or their more aggressive Good Behavior Game classmates. These are issues for examination in follow-up studies involving smokers vs nonsmokers within

Cohort: II

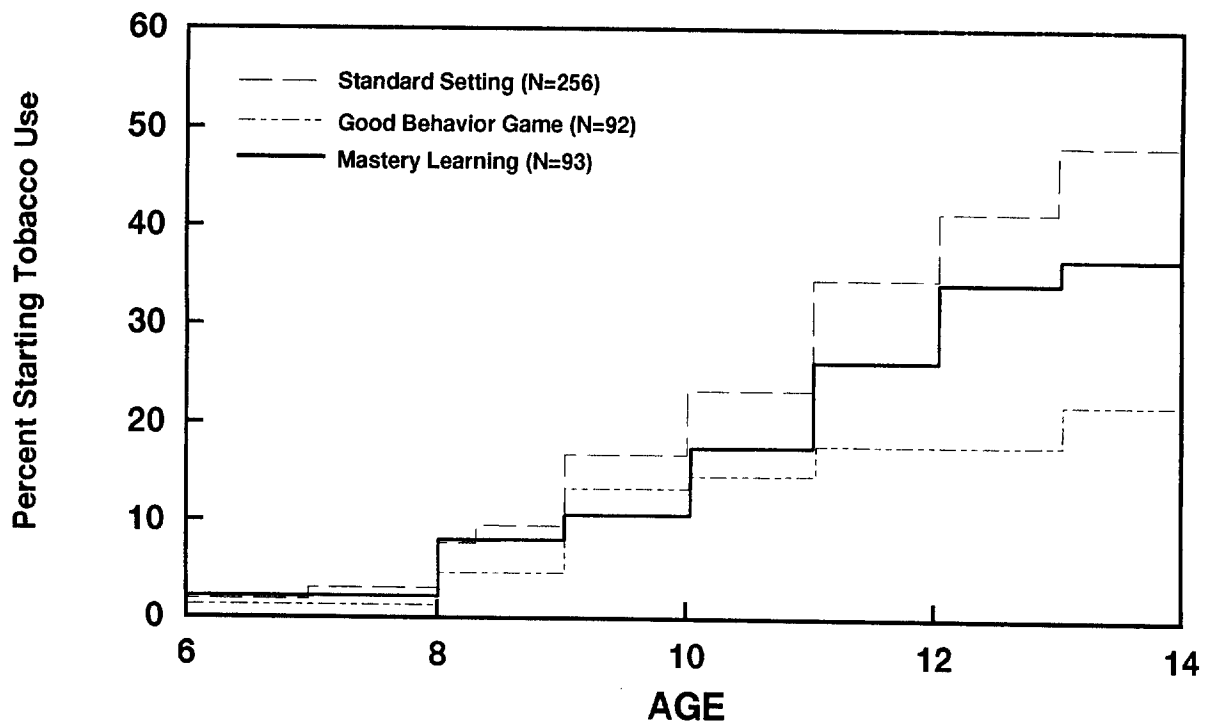


FIGURE 2—Impact of Mastery Learning and Good Behavior Game on boys in first and second grades in terms of initiation of tobacco smoking through 14 years of age: cohort 2.

TABLE 2—Estimated Relative Risk of Initiating Smoking, by Tertile of Aggressive/Disruptive Behavior in First Grade and by Sex: Baltimore Preventive Field Trial, 1985–1994

Designated Subgroup	Intervention/Control Status	Estimated Relative Risk	95% Confidence Interval	P
Boys in grade 1				
Lower aggressive/ disruptive (n = 253)	Good Behavior Game (n = 41)	0.13	0.03, 0.62	.011
	Mastery Learning (n = 58)	0.60	0.31, 1.18	.137
	Control (reference) (n = 154)	1.00	...	...
Middle aggressive/ disruptive (n = 285)	Good Behavior Game (n = 52)	0.82	0.38, 1.77	.618
	Mastery Learning (n = 75)	0.96	0.46, 2.01	.918
	Control (reference) (n = 158)	1.00	...	...
Higher aggressive/ disruptive (n = 270)	Good Behavior Game (n = 84)	0.57	0.25, 1.28	.172
	Mastery Learning (n = 41)	0.77	0.33, 1.77	.540
	Control (reference) (n = 145)	1.00	...	...
Girls in grade 1				
Lower aggressive/ disruptive (n = 262)	Good Behavior Game (n = 63)	1.00	0.30, 3.38	.997
	Mastery Learning (n = 51)	1.09	0.57, 2.10	.786
	Control (reference) (n = 148)	1.00	...	...
Middle aggressive/ disruptive (n = 263)	Good Behavior Game (n = 49)	0.63	0.28, 1.43	.273
	Mastery Learning (n = 67)	2.21	0.78, 6.29	.137
	Control (reference) (n = 147)	1.00	...	...
Higher aggressive/ disruptive (n = 271)	Good Behavior Game (n = 59)	1.13	0.48, 2.67	.773
	Mastery Learning (n = 60)	1.35	0.60, 3.05	.472
	Control (reference) (n = 152)	1.00	...	...

Note. Estimates were derived from the conditional form of the Cox proportional hazards model, with risk set stratification by school at entry into first grade.

subgroups defined by sex, early aggressive/disruptive behavior, other mediators and moderators, and intervention assignment.

The Mastery Learning results are important for 2 reasons. The first is the

specificity of the Good Behavior Game; if the game's impact was a nonspecific benefit of special attention, then the impact of Mastery Learning should have been comparable to that for the Good Behavior Game. Sec-

ond, mixed results with respect to Mastery Learning should not lead to dismissal of possible smoking prevention via improving school achievement. In both cohorts, the age 14 cumulative risk estimates for Mastery

Learning boys were intermediate, above levels observed for Good Behavior Game boys but below expected values in control classrooms. In cohort 2, reductions associated with Mastery Learning were statistically significant ($P < .05$). With continued follow-up, these cohorts may show more substantial evidence of Mastery Learning impact.

The Good Behavior Game and Mastery Learning are "universal" interventions received by all children in classrooms, not merely those at higher risk.³³ They are implemented by regular classroom teachers during the regular school day. They are economical in terms of time and money, reducing teacher burden rather than increasing it. In contrast to smoking prevention efforts that focus on the unpleasant or harmful effects of tobacco or promote teenagers' resistance to peer pressure to smoke, the Good Behavior Game targeted a much earlier developmental antecedent for teenage smoking. Our results support a general prevention research strategy of targeting early risk factors as complements to effective interventions in later years. Prevention studies can identify new, potentially malleable developmental antecedents of smoking, later targeting them as antecedents for change.^{3,4} □

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The original search for a behavioral intervention to address the social adaptation process between teacher and children was led by Dr Alan Harris, and the implementer and supervisor was Dr Jaylan Turkhan. Dr Lawrence Dolan developed and implemented the Mastery Learning intervention based on the work of Benjamin Bloom and was the first field supervisor. Dr Lisa Werthamer followed Dr Dolan, and she and Dr Nicholas Ialongo have made important contributions. Dr C. Hendricks Brown con-

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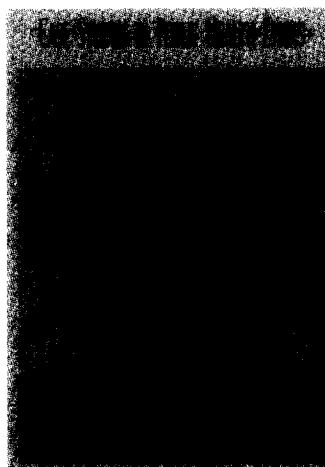
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