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Effects of Decreasing Sedentary Behaviors on Activity Choice in Obese Children

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In this study, methods of decreasing highly preferred sedentary behaviors were compared and the consequent effects on activity choice were examined. Following free choice of sedentary and physical activities, 34 obese children either were positively reinforced for decreases in high-preference sedentary activity, were punished for high-preference sedentary activity, had access to high-preference sedentary activity restricted, or had no contingencies on activity (control group). Children randomized to reinforcement and punishment were more physically active on intervention days than the control group. Liking for targeted sedentary activity decreased in the reinforcement group, but increased in the restriction and control groups. Results suggest that reinforcing decreases in high-preference sedentary activity can increase physical activity and decrease liking for targeted sedentary activities.

Key words: activity, sedentary behaviors, behavioral economics, choice, childhood obesity

Increasing physical activity is an important component of childhood weight-management programs (Epstein, 1992; Epstein, Coleman, & Myers, 1996). Studies have shown that obese children are less physically active, perceive physical activity more negatively (Worsley, Coonan, Leitch, & Crawford, 1984), and find sedentary activities more reinforcing than physical activities relative to normal weight children (Epstein, Smith, Vara, & Rodefer, 1991). The development and maintenance of higher physical activity levels for obese individuals have proven challenging (Dishman, 1990; Epstein, Koeske, & Wing, 1984; Martin & Dubbert, 1982). Research has suggested that physical activity can be increased by using standard behavioral strategies such as self-monitoring, goal setting, and positive reinforcement (Epstein, Saelens, & O'Brien, 1995; Epstein, Woodall, Goreczny, Wing, & Robertson, 1984; Keefe & Blumenthal, 1980; Noland, 1989). However, these strategies generally have been unsuccessful in producing long-term increases in physical activity (Dishman, 1991), stimulating the need to explore alternative methods to increase physical activity over a long-term period.

Behavioral economic theory (Hursch & Bauman, 1987; Rachlin, 1989) can be used to conceptualize being physically active as a choice between physically active and sedentary behaviors. One reason for the low activity levels in obese persons may be that extremely reinforcing sedentary behaviors compete with physically active behaviors. For example, television watching is one prominent sedentary behavior that can compete with physical activity. Both adults' and children's television viewing have been shown to be negatively correlated with physical activity and fitness (Durant, Baranowski, Johnson, & Thompson, 1994; Tucker, 1986, 1993; Tucker & Bagwell, 1991) and positively correlated with obesity (Dietz & Gortmaker, 1985; Gortmaker, Dietz, & Cheung, 1990; Tucker & Bagwell, 1991). Decreasing sedentary activities such as television watching can increase the time and opportunity for physical activity. The reallocation of even a small portion of time spent in sedentary behaviors to time spent being physically active has been shown to have a significant impact on energy balance and fitness (Blair, 1993; Pate et al., 1995).

Recent studies have shown that reductions in selected sedentary behaviors are associated with increases in children's physical activity (Epstein, Saelens, et al., 1995; Epstein et al., 1991; Epstein, Valoski, et al., 1995). Children shifted from preferred sedentary behaviors to physically active alternatives when access to the sedentary activities was reduced by increasing the cost of engaging in these sedentary behaviors (Epstein et al., 1991). Obese children reinforced for reducing time spent being sedentary or reinforced for being more physically active similarly increased their amount of time being physically active relative to a no-contingency control group (Epstein, Saelens, et al., 1995). In a treatment-outcome study, obese children who were reinforced for decreases in the time they were sedentary had significantly greater reduction in percentage overweight at the end of treatment in comparison with children who were reinforced for increases in physical activity. Children reinforced for reductions in sedentary time also had a greater increase in liking of high-intensity physical activi-

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ties than children reinforced for increases in physical activity (Epstein, Valoski, et al., 1995).

In the studies cited above, the approaches to decreasing sedentary behaviors were to increase the cost of choosing sedentary alternatives, or to reinforce children for reductions in the time they spent on their most preferred sedentary behaviors. However, other behavior-change techniques may be used to decrease the time spent engaged in preferred sedentary behaviors. One alternative method to decrease high-preference sedentary behaviors is to punish children for being sedentary. Another approach is to remove the opportunity to be sedentary by eliminating targeted sedentary activities from the environment (i.e., restriction). Despite the importance of understanding the influence of basic behavioral processes in modifying activity choice, there is no previous research contrasting the efficacy of positive reinforcement, punishment, and restriction for reduction of sedentary behaviors. In addition, it is unclear how these techniques for reducing targeted sedentary activity will influence reallocation of time for active and nontargeted sedentary activities.

The goal of the present study was to replicate and extend, in a controlled laboratory setting, the previous finding that targeting a reduction in high-preference sedentary activities results in a partial reallocation of time to physically active behaviors rather than exclusively to lower preference sedentary activities (Epstein, Saelens, et al., 1995). The current study extends previous research by contrasting the efficacy of three methods on modifying physical and sedentary activities and liking of physical and sedentary activities: positively reinforcing children for being less sedentary, punishing them for being sedentary by removing positive reinforcers contingent on being sedentary, or restricting access to sedentary activities.

Method

Participants

Participants were 8- to 12-year-old obese children of parents who had applied to the Childhood Weight Control program at the State University of New York at Buffalo but had not yet been enrolled in the program. Ninety-three applicant families had children who met inclusionary criteria for age and obesity status. Families were contacted by telephone and asked to participate in a study involving children's choices. Thirty-three White and 4 African American children participated in the study.

Three participants were eliminated from data analysis: 2 participants were outliers (>2 standard deviations) on physically active time during the preintervention day, and 1 participant had uncodable behavioral data. The final sample consisted of 34 participants, including 20 girls and 14 boys. Children were paid $50 for their participation in addition to the reinforcers earned during the study. This study was approved by the Social Sciences Human Subject Review Committee at the State University of New York at Buffalo.

Procedure

Children were stratified by gender and randomly assigned to one of four groups: positively reinforced for not engaging in their two high-preference sedentary activities (reinforcement; $n = 8$), punished for engaging in their two high-preference sedentary activities (punishment; $n = 9$), access to their two high-preference sedentary activities eliminated (restriction; $n = 8$), or a control group that was reinforced for attendance with no contingencies on activity (control; $n = 9$). *High-preference sedentary activities* were defined as the two sedentary activities the child engaged in for the most time during the preintervention day, whereas the *low-preference sedentary activities* were the two sedentary activities the child engaged in for the least time during the preintervention day. Targeted activities were specified individually for each child, and children remained in the same assigned group across intervention days.

The contingencies were arranged such that children in the reinforcement group earned 1 point for each minute not spent in high-preference sedentary activities, with a maximal daily point value of 45 points. Children in the punishment group were given 45 points at the beginning of each session, and lost 1 point for every minute of high-preference sedentary activity they accumulated. Children in the restriction and control groups were given 45 points on each intervention day, regardless of their activity choices. The reinforcement, punishment, and control groups had access to all eight of the activities on every day, whereas the restriction group had access to all eight activities on the adaptation, preintervention, and postintervention days, but had access only to the four physically active and two low-preference sedentary activities during the intervention days.

Children were brought individually into the laboratory for 6 consecutive days. There was 1 adaptation day, followed by 1 preintervention day, 3 intervention days, and 1 postintervention day. During the adaptation session, parent and child consent were obtained and children were adapted to the laboratory room, instructed on how to use the activities, and given 20 min to sample the activities. The room contained four physical activities and four sedentary activities. The physical activities included a Tunturi Executive Ergometer stationary bicycle (Tunturi, Bellevue, WA), a Precor 718e Low Impact Climber (Precor, Bothell, WA), a Nordic Track Speed Skating Slide, and a Nordic Track Twist 'N Ski Junior (Nordic Track, Chaska, MN). The sedentary activities were a videocassette recorder (VCR) and monitor with current children's movies, a Super Nintendo Model SNS-001 video game (Nintendo, Redmond, WA), reading books, and drawing and coloring materials. Children were instructed to engage in only one activity at a time. After adaptation, children rated their liking of the activities and child and parent height and weight were assessed.

Preintervention, intervention, and postintervention sessions lasted 45 min. On the preintervention day, children were given free choice of the activities. On the intervention days, children were provided with information on how they could earn points dependent on their group assignment and were shown a point-to-reinforcer menu that indicated the point values for each reinforcer. Children were told their current point totals at the beginning and end of each session. Children in the reinforcement group were instructed that they would earn one point for each minute that they did not spend doing high-preference sedentary activities; children in the punishment group were instructed that they would lose a point for each minute they spent doing their high-preference sedentary activities. In the restriction group, the high-preference sedentary activities were removed prior to the child entering the laboratory room, and children were instructed that they could engage in the remaining physically active and low-preference sedentary activities. Children in all groups were told that it was their choice whether or not to engage in any available activity. Reinforcers included Buffalo Bison baseball tickets, bookstore gift certificates, video arcade tokens, Buffalo Zoo and Science Museum passes, and other child-related community activities. After the final intervention

session, children chose reinforcers according to the number of points earned during the 3 intervention days. On the postintervention day, contingencies were removed and children were given free choice of all eight activities, similar to the preintervention day. After completing the postintervention session, children completed liking ratings for the activities.

Measurements

Child and parent weight were measured on a balance-beam scale, and height was measured on a stadiometer calibrated to the nearest 1/8 in. Body mass index (BMI) was calculated by the formula kg/m^2. *Percentage overweight* was the percentage above the 50th-percentile BMI for people similar in age and gender (Must, Dallal, & Dietz, 1991), and *obesity* was defined as percentage overweight greater than 20%.

Children were observed through a one-way mirror during sessions, and a 30-s time-sampling behavioral coding system was implemented for each 45-min session to measure the amount of time children spent engaged in each activity. Twenty-eight percent of the sessions were observed by two independent observers. The percentage agreement on interrater reliability for individual sessions was .94 (range = .73–1.00), with reliabilities for individual physical activities ranging from .86–.89 and reliabilities for individual sedentary activities all >.98. Children were engaged in one of the eight activities for 89% of the observation intervals, with remaining intervals primarily consisting of children being between activities. Only intervals in which children were engaged in one of the eight activities were included in data analysis.

Liking of the activities was measured by using 100-mm visual analog scales anchored by *did not like at all* and *liked a lot.* Children rated each individual activity, and the average liking of the four physical activities, two high-preference sedentary activities, and two low-preference sedentary activities was calculated. The Four Factor Index of Social Status (Hollingshead, 1975) was used to determine family socioeconomic status, by means of assessment of parental educational level and occupational status.

Analytic Plan

One-way analyses of variance (ANOVAs) were conducted to investigate group differences on child and parent BMI, and on child age. Three-way mixed ANOVAs were used to explore differences in time spent in activities and liking of activities. In the activity analysis, group was the between-subjects variable, and activity (physical, high-, and low-preference sedentary) and day (preintervention, intervention, postintervention) were the within-subjects variables. The dependent variable for the activity analyses was the number of 30-s intervals spent in the physically active, high-preference sedentary, and low-preference sedentary activities during the 45-min session. For the liking analysis, group was the between-subjects variable, and activity and time (adaptation to postintervention) were the within-subjects variables. The dependent variable for the liking analysis was the average liking score.

Follow-up two-way ANOVAs were conducted for each type of activity to explore Group × Day and Group × Time interactions in the activity and liking analyses, respectively. Planned linear contrasts were used to explore group differences in activity between free choice (pre- and postintervention) and intervention days and change across intervention days. Planned linear contrasts were further used to explore group differences in activity time on the pre- and postintervention days and group differences in activity liking on the adaptation and postintervention days. To explore relationships between liking of activities and activity choice, Pearson product–moment correlations were calculated between ratings of liking measured on the adaptation day and time spent being physically active on the preintervention, postintervention, and across intervention days. Data analyses were conducted using the SYSTAT statistical package (Wilkinson, 1992).

Results

Family socioeconomic status ranged from 14 to 66, with a mean of 43.0 (SD = 12.9), suggesting lower- to upper-middle-class status for most participating families. There were 6 single-parent and 31 two-parent families, with an average of 2.4 (SD = 1.1) children per family. The average participant was 10.0 (SD = 1.2) years of age and 62% (SD = 23%) overweight. Mothers were an average of 45% (SD = 38%) overweight, and fathers were an average of 38% (SD = 28%) overweight. There were no significant group differences in child or parent BMI or in child age.

Activity

A significant three-way interaction (Group × Day × Activity) for activity was found, $F(24, 240) = 5.74$, $p < .001$. As shown in Figure 1, the Group × Day interaction was significant for time spent on the physical activities, $F(12, 120) = 2.00$, $p = .03$. Linear contrasts revealed that the reinforcement group, $F(1, 30) = 6.53$, $p = .016$, and punishment group, $F(1, 30) = 7.72$, $p = .009$, were significantly more physically active on the intervention days than the control group but were not different from each other. The restriction group was not significantly different in physically active time from any of the other three groups, though the restriction group versus the control group contrast approached significance, $F(1, 30) = 3.90$, $p = .057$. There was a significant effect of day for time spent being physically active, $F(4, 120) = 16.39$, $p < .001$. Linear contrasts across days showed a decrease in physical activity from the first to the second intervention day, $F(1, 30) = 4.91$, $p = .034$, but no significant changes from the second to the third intervention day.

There was a significant Group × Day interaction, $F(12, 120) = 9.97$, $p < .001$, for time spent in high-preference sedentary activities, with the reinforcement, punishment, and restriction groups engaging in significantly less high-preference sedentary activity than the control group during the intervention days. No significant differences were found among the reinforcement, punishment, or restriction groups, and there was no significant change in level of high-preference sedentary activity across intervention days. There were no significant group differences in the number of points earned for the reinforcers, with all group means ≥130 points out of a possible 135 points.

The Group × Day interaction for time spent in low-preference sedentary activities was significant, $F(12, 120) = 3.26$, $p < .001$, with the reinforcement, punishment, and restriction groups engaging in more low-preference sedentary activity than the control group on the intervention days, but not differing significantly amongst themselves. There was a significant increase in low-preference sedentary activity from the first to second intervention day, $F(1, 30) =$

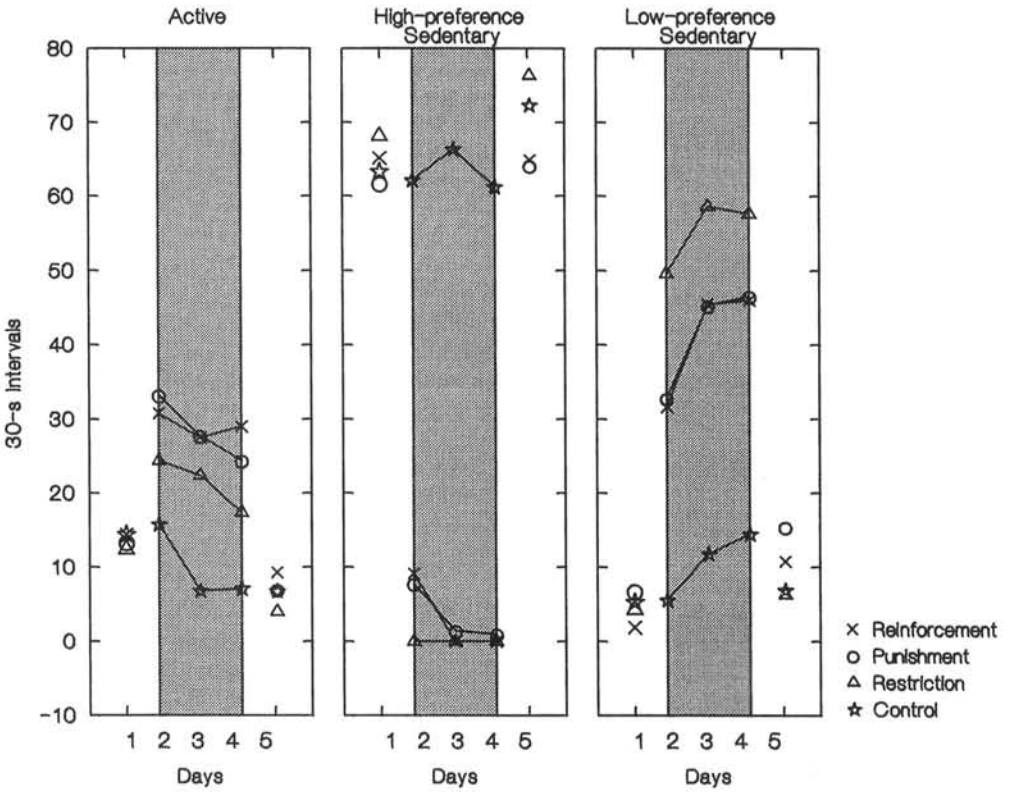

Figure 1. Time spent in physical activities and high- and low-preference sedentary activities for the reinforcement, punishment, restriction, and control groups across the preintervention (Day 1), intervention (Days 2–4), and postintervention (Day 5) days.

6.58, $p = .016$, but no change from the second to third intervention day. Across the intervention days, there was no significant Group × Day interaction for low-preference sedentary activity.

As shown in Figure 1, there were no significant group differences in time spent in physical, high-preference sedentary, or low-preference sedentary activities on the preintervention and postintervention days. In addition, there were no significant group differences in the change from preintervention to postintervention in time spent in the physical, high-preference sedentary, or low-preference sedentary activities.

Liking of Activity

Significant differences were observed in the liking ratings for the different types of activities measured on the adaptation day, $F(2, 90) = 11.06$, $p < .001$. The liking ratings of both the physical activities ($M = 72.0$, $SD = 3.8$) and high-preference sedentary activities ($M = 67.4$, $SD = 3.8$) were significantly higher than the liking rating of the low-preference sedentary activities ($M = 48.1$, $SD = 3.8$), but were not significantly different from each other: $F(1, 90) = 19.65$, $p < .001$ and $F(1, 90) = 12.80$, $p < .001$. There was no significant main effect of group or Group × Activity interaction for liking ratings on the adaptation day.

A significant Group × Time × Activity interaction for liking of activities was found from adaptation to postintervention, $F(6, 90) = 2.61$, $p = .022$. As shown in Figure 2, there was a significant Group × Time interaction for liking of high-preference sedentary activities, $F(3, 30) = 4.31$, $p = .012$. Linear contrasts showed significant differences over time in liking of high-preference sedentary activity between the reinforcement and restriction groups, $F(1, 30) = 6.84$, $p = .014$; the reinforcement and control groups, $F(1, 30) = 10.97$, $p < .002$; and the punishment and control groups, $F(1, 30) = 4.20$, $p = .049$. The control and restriction groups increased their liking of the high-preference sedentary activities across time, and the reinforcement and punishment groups respectively decreased and maintained their liking ratings for high-preference sedentary activity across time. The Group × Time interactions for liking of physical activities and low-preference sedentary activities were not statistically significant, and there were no significant group differences in liking for the physical or low-preference sedentary activities on the adaptation or postintervention day.

Pearson product–moment correlations showed that liking of high-preference sedentary activity measured on the adaptation day was significantly inversely related to the amount of time spent being physically active on the preintervention day, $r(34) = -.47$, $p = .037$, (Bonferroni corrected), but was not significantly correlated with total

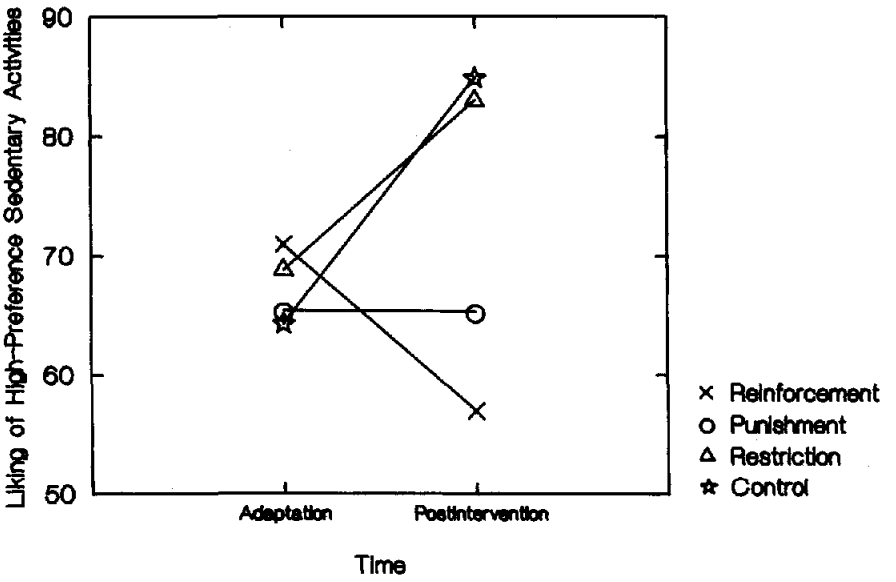

Figure 2. Liking ratings of the high-preference sedentary activities on the adaptation and postintervention days in the reinforcement, punishment, restriction, and control groups. Liking of activities was measured with 100-mm visual analog scales anchored by *did not like at all* and *liked a lot*.

physically active time during the intervention days. None of the other liking ratings assessed on the adaptation day were significantly correlated with physically active time on the preintervention, postintervention, or intervention days.

Discussion

The behavioral strategies that reinforced children for reducing time spent being inactive, or that punished children for time spent being inactive, were as successful as removing access to targeted inactive behaviors from the child's environment in reducing time spent in targeted sedentary activities. All groups spent the majority of their time engaged in their high-preference sedentary activities (group $M > 74\%$ of intervals) on the preintervention and postintervention days. Children in the control group maintained their high level of high-preference sedentary activities across the intervention days. Children in the intervention groups reallocated time they had spent in high-preference sedentary behaviors to both physical activity and lower-preference sedentary behaviors when the experimental contingencies were in effect. Children who were reinforced for not engaging in high-preference sedentary activities or penalized for engaging in high-preference sedentary activities significantly increased their physical activity and their time spent in low-preference sedentary behaviors. Children who experienced restriction of high-preference sedentary activities also increased their time spent in lower-preference sedentary behaviors, but they did not show an increase in physical activity that was significantly different from the control group or the other two intervention groups.

Reinforcement and punishment were more effective than restriction for increasing children's physical activity. Differential changes in liking of the targeted sedentary activities also favored using reinforcement or punishment instead of restriction. This differential change in liking of high-preference sedentary activities occurred despite similar time spent in the high-preference sedentary behaviors among the reinforcement, punishment, and restriction groups. The mechanism by which the liking changes occurred is unclear, although possible explanations include group differences in the perception of choice and affective associations with the activity (Sidman, 1989). The more the children felt that they chose not to engage in their high-preference sedentary behavior (reinforcement and punishment groups) as opposed to being coerced into not engaging in these targeted behaviors (restriction group), the less they liked these targeted sedentary behaviors.

Changes in liking of sedentary activities that compete with physical activity have relevance for activity choice. At the preintervention day, the less that children liked the high-preference sedentary activities, the more physically active they were. Previously, the same significant negative correlation between liking of high-preference sedentary activity and physical activity during free choice had been observed (Epstein, Saelens, et al., 1995). However, it is prudent not to assume that the reported liking of a behavior is veridical to behavior or that changes in liking represent mechanisms for behavior change. For example, children rated their liking of physically active behaviors as equal to their liking of preferred sedentary behaviors before contingencies were implemented, but they consistently spent more time being sedentary than physically active during the pre- and postintervention sessions. In addition, children reinforced for reductions in their sedentary activity returned to their low baseline levels of physical activity at the postintervention day, despite a decrease in liking of their high-preference sedentary activities.

The differential changes in both physical activity and ratings of activity liking suggest that either reinforcement or punishment are more effective methods than restriction for increasing physical activity. An important difference between reinforcement and punishment versus restriction is the access to the targeted high-preference sedentary behavior. In the restriction condition, access to high-preference sedentary behaviors was removed, and the reallocation to physical activity or low-preference sedentary behaviors was the direct result of the restriction. Participants in the restriction condition could not perceive that changes in targeted sedentary activity were related to their choice or under their control. On the other hand, children in the reinforcement and punishment groups had the opportunity of engaging in high-preference sedentary activities but chose instead to engage in both physical activities and low-preference sedentary activities. The behavioral changes in these children were likely to be more a function of the contingencies, not of access to the behaviors.

The coercive nature of restriction may have reduced the attribution that participants engaged in the behavior because it was their choice. Research has shown higher levels of physical activity (Martin et al., 1984; Orlick & Mosher, 1978; Thompson & Wankel, 1980) associated with greater choice among exercise activities and goals, and exercise programs that enhance choice (e.g., lifestyle vs. programmed exercise) have been associated with greater long-term exercise adherence than programs with less or no choice (Epstein, Wing, Koeske, & Valoski, 1985; Garcia & King, 1991). Providing choice may also enhance the perception of control (Epstein, Saelens, et al., 1995; Epstein, Valoski, et al., 1995). It has been shown that people are more likely to begin exercise programs and adhere to those programs if they feel they are in control of their exercise behavior, shown either by positive relations between being physically active and internal locus of control (Noland & Feldman, 1985; Slenker, Price, & O'Connell, 1985) or negative relationships to external control (Long & Haney, 1986). Likewise, weight control programs for children and adolescents that maximize self-control as opposed to parental control have been associated with superior weight loss (Cohen, Gelfand, Dodd, Jensen, & Turner, 1980), although this has not always been found (Epstein, Wing, Koeske, & Valoski, 1986).

The equivalent changes in allocation of time from preferred sedentary behaviors to physically active behaviors in the positively reinforced and punished groups suggest that either positive reinforcement or punishment could be useful in interventions to reduce inactivity. However, there are reasons to favor the use of positive reinforcement over punishment. Positive reinforcement has been associated with positive affect and the desire to repeat the behavior to gain access to positive reinforcers, whereas punishment has been associated with negative affect, which is generated by participants' perception of punishment as a coercive process (Catania, 1980; Emurian, Emurian, & Brady, 1985; Sidman, 1989). Positive reinforcement has been shown to be more likely than punishment to promote positive behavior when the contingencies are removed (Rushton & Teachman, 1978), and a substantial body of research has suggested that positively motivated behavior is more likely to enhance motivation for a behavior than punishment, which decreases motivation to engage in a behavior (Fair & Silvestri, 1992). Studies have shown that from the perspective of the individual, punishment is evaluated negatively whereas positive reinforcement is evaluated positively (Rachlin, 1989; Sidman, 1989). Likewise, persons who behave because of punishment or fear of criticism have been rated as less intrinsically motivated than those who behave to receive praise (Peterson & Gelfand, 1984). Finally, there are well-documented differences in the acceptability (Heffer & Kelley, 1987) of positive reinforcement and punishment that favor positive reinforcement.

An alternative intervention for reducing time spent on high-preference sedentary behaviors is to attempt to increase activity by directly reinforcing children for being more physically active, with minimal attention paid to sedentary alternatives. Prior laboratory and clinical studies have suggested that both reinforcing decreases in sedentary activity and reinforcing increases in physical activity result in increases in physical activity (Epstein, Saelens, et al., 1995; Epstein, Valoski, et al., 1995). Reinforcing a reduction in high-preference sedentary behaviors differentially reinforces behaviors other than the targeted sedentary behaviors (Differential Reinforcement of Other Behavior schedule of reinforcement), and the behaviors that are reinforced are chosen by the child. Reinforcing a reduction in sedentary behaviors may enhance perception of control over active behaviors more than directly reinforcing physically active behaviors (Epstein, Saelens, et al., 1995; Epstein, Valoski, et al., 1995), but this has not been directly tested and additional laboratory and clinical research addressing this comparison is needed.

Replicating the efficacy of reducing high-preference sedentary behavior to increase physical activity is a step in the process of finding methods to produce enduring increases in children's physical activity. Future research should explore the effects of longer-term implementation of contingencies that focus on reducing sedentary activity and the effects of such contingencies on long-term physical activity levels. The results of this study suggest that positively reinforcing children for being less sedentary or punishing them for being sedentary are both more effective methods for increasing physical activity than a restriction method that reduces access to the sedentary behaviors. However, positive reinforcement may be the more desirable method, as it was the only strategy that both increased physical activity and decreased liking for high-preference sedentary activities.

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