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Effect of Increasing the Choice of Active Options on Children's Physical Activity

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Abstract

Objectives—To determine whether increasing the choice of physical activity options increases the duration and intensity of children's physically active play.

Design—This cross-sectional laboratory study included gender (male, female) and choice group [single toy (no choice), three toys (low choice), five toys (high choice)] as between participant factors.

Methods—Boys and girls ($n = 36$, 8–12 y) were stratified, randomly assigned to a choice group that always provided access to each participant's most liked active toy(s), and allowed 60 min of free time. The same sedentary alternatives were freely available to all participants. Physical activity outcomes were measured by accelerometry, heart rate, and direct observation.

Results—The number of active toys the children played with increased ($p < 0.001$) across each choice group. Minutes spent in MPA were greater in the low choice ($p < 0.05$) and high choice ($p < 0.02$) groups than the no choice group. Active play time was greater ($p < 0.01$) in the low choice (79%) and high choice (95%) groups compared to the no choice group. Girls in the low and high choice groups had greater ($p < 0.05$) percent heart rate reserve when compared to girls in the no choice group. There was no difference in the boys' percent heart rate reserve between the no choice, low choice and high choice groups.

Conclusions—Increasing the choice of active toys increases both the duration and intensity of physically active play, especially in girls.

Keywords

Obesity; Child behavior; Exercise; Play and playthings; Accelerometer

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Introduction

Adults and children consistently increase their food consumption when provided with a greater choice of foods.^{1, 2} Laboratory studies have established that various parameters (e.g., tastes, textures, temperatures) of food choice promote greater eating.³ Laboratory studies have also shown that presenting a greater choice of fruits and vegetables encourages increased consumption of these healthful foods.⁴ The choice or variety effect on food consumption has recently been translated into a clinical weight loss trial that demonstrated reductions in dietary food variety can lead to reduced energy intake and weight control.⁵

Just as the influence of food variety or choice on children's eating behaviors has been demonstrated in well-controlled laboratory studies⁶, there is a need for laboratory research to establish whether the choice of play equipment increases children's physical activity, and to establish the parameters of physical activity choice (e.g., number of toys, duration of play) that produce the greatest increases in physical activity. If choice or variety elicits a robust effect that acts across weight control behaviors, presenting children with a greater choice of options for physically active play could increase their physical activity participation.

Current guidelines for children's physical activity include participation in a diversity of physical activities to produce overall muscular, aerobic and anaerobic fitness.⁷ When engaged in physically active play, children intermittently change from rest to physical activity, known as 'bouts.'^{8, 9} Children's physically active play is an important factor in the promotion of muscle differentiation, endurance, strength, and economy and skill of movement.¹⁰ Physically active play may also have cognitive benefits as a break from other activity and as a way to establish social status among peers.¹⁰ But as children approach adolescence, the percentage of time they spend in different types of play decreases.¹⁰ Finding ways to motivate older children to be physically active has potential benefit through prolonging the benefits derived from physically active play, as well as preventing the development of childhood obesity and risk factors for diseases such as coronary heart disease and diabetes.^{11, 12} The potential positive effects of increasing the available choice of activities on physically active play and physical activity participation have not yet received much scientific attention.

We recently used resistance training as a physical activity model to study the effect of choice on physical activity participation. The resistance training model allowed for easy manipulation of the number of choices by controlling access to the number of different movements within a single mode of exercise. Children performed a greater number of repetitions, lifted more total weight, and indicated greater liking of the exercise session in the high-choice versus low-choice condition.¹³ However, the results of this study can only be extended to the type of physical activity the children performed: resistance training. This research should be extended by determining the effect of choice on more commonly used physical activity equipment such as basketball, jumping games, and other active toys. To truly manipulate choice, research should examine more than a no/low choice (e.g., access to a single piece of equipment) condition and a higher choice condition (e.g., access to five pieces of equipment). An additional medium-choice condition (e.g., access to three pieces of equipment) would provide a better test of the dose-response relationship of choice on physical activity. Thus, the purpose of the current study was to extend previous research by determining whether increasing the choice of commonly utilized active toys a child has access to increases the amount and intensity of physically active play in which they engage.

Methods

Participants included 18 boys ($n = 16$ Caucasian; $n = 1$ Asian; $n = 1$ Other) and 18 girls ($n = 16$ Caucasian; $n = 1$ Asian; $n = 1$ African-American), who were 8–12 years old and $< 95^{\text{th}}$ Body Mass Index (BMI) percentile.¹⁴ Children could have no history of disorders that would affect their ability to exercise, including cardiovascular, neuromotor, cognitive or orthopedic disorders. Researchers screened each child's history pertinent to study inclusion criteria prior to their acceptance into the study. Two children were rejected for not meeting study inclusion criteria. Children were instructed not to eat anything one hour prior to their appointments. Parents provided written consent for their child to participate and each child gave their written assent to participate. The University at Buffalo Children and Youth Institutional Review Board approved this study.

Each child was tested in the laboratory on two days. On the first day, children sampled each active toy for three minutes, resting for two minutes between each toy. Active toys included mini hockey (hockey stick, ball, cones, hockey net), toss across (bean bag toss combined with a tic-tac-toe game), mini indoor basketball (basketball hoop, mini-basketballs), skip-it (ankle ring with attached ball to jump over), and jump rope. The order of sampling was counterbalanced across all children. Children rated each toy using a ten-point Likert scale, anchored by "like it very much" on the lower end (1) and "do not like at all" on the upper end (10).¹⁵ Children also indicated (yes/no) if they had previous experience with each toy.

On the second day, after each child was fitted with an Actigraph GT1M accelerometer (Pensacola, Florida) and Polar S625X heart rate monitor (Kempele, Finland) they rested quietly for 10 minutes while reading magazines, drawing or completing puzzles. After the rest session, each child was given 60 minutes to play. Boys and girls were stratified and then randomized to one of three groups ($n = 6$ boys; $n = 6$ girls per group): one toy (no choice), three toys (low choice) or five toys (high choice). If the child was assigned to the no choice or low choice group, they were given their favorite or top three favorite toys (as determined on the first day), respectively. The high choice group was given access to all five toys, which included their most liked toy. All groups were granted equal access to sedentary activities including children's magazines, puzzles and paper for drawing. Sedentary activities were located on a table with a chair within the same room as the physical activities. No constraints were placed on the amount of physical or sedentary activity or the intensity of physical activity.

Socioeconomic status (SES), race and ethnicity were obtained using a standardized questionnaire completed by the child's parent.¹⁶ Body weight was measured to the nearest 0.1 kg using a Tanita electronic weight scale. Height was assessed to the nearest 0.01 cm using a calibrated Seca stadiometer. BMI (weight in kg/height in m^2) percentile was calculated in relationship to 50th BMI percentile for children based on their age and gender.¹⁴

Duration of physical activity and activity choices were measured through observation by trained research staff via closed circuit video cameras. A scoring spreadsheet was developed for the study to track the time engaged with each active or sedentary choice. As children moved from one choice to another, the activity and time since the beginning of the session was recorded on the spreadsheet. The total time engaged in each activity was then computed by subtraction after the session. All staff were trained to score the session by having them initially score a practice session with the trainer. Staff were not allowed to score a session until they had 100% agreement on categorizing children's activities with the trainer. Staff were also given scripts to follow to explain the study appointments, and trained on proper positioning of the heart rate monitor. Active play time was defined as the duration the child

engaged in any activity with an active toy. Sedentary time was defined as the duration of time a child engaged in alternative choices such as resting quietly, reading children's magazines or completing puzzles. Children were allowed to engage in only one activity at a time. Children wore an ActiGraph GT1M accelerometer (ActiGraph, Pensacola, Florida), initialized with a 15-sec epoch.^{17, 18} The monitor was worn snug against the hip in a pouch attached to a belt. Heart rate was measured every 5 seconds and averaged across the entire one-hour lab session using a Polar S625X heart rate monitor (Polar Electro, Kempele, Finland).

Accelerometer data were converted to metabolic equivalents (METs, 1 MET = 3.5 ml·kg⁻¹·min⁻¹ of oxygen consumption) based on each child's age.¹⁸ Minutes spent in light physical activity (LPA, 1–2.9 METs), moderate-to-vigorous (MPA, 3–5.9 METs), vigorous physical activity (VPA, ≥ 6 METs) were calculated for each 60-minute laboratory session. Intensity of bouts of physical activity were computed based on 15 sec accelerometer data. Physical activity bout durations of 15 sec, 30 sec, 1 min, 3 min and 5 min were included in the analysis only if they met the threshold for MVPA (≥ 3 METs) for the entire time segment. Heart rate reserve and percent heart rate reserve were computed using estimated maximal heart rate and resting heart rate.¹⁹

Separate two-way ANOVA models were used to assess differences in demographics, physical characteristics, liking of toys and sedentary alternatives, number of toys played with, physical activity duration, heart rate reserve, percent heart rate reserve, MVPA play bouts (total number, 15 sec, 30 sec, 1 min, 3 min and 5 min), and minutes in LPA, MPA, VPA with gender (boys, girls) and choice group (1-toy, 3-toys, 5-toys) treated as between participant variables. Contrast statements were used to explore significant main effects of choice group or of gender by choice group interactions. Pearson correlations between previous experience with the toys and the child's liking and rank of the toys were completed to explore any impact previous experience with the toys had on toy ranking.

Results

No gender or choice group differences were found for the physical characteristics and demographics presented in Table 1. There were differences between boys' and girls' liking of jump rope (5.6 versus 8.3, $p < 0.001$) and hockey (8.8 versus 6.1, $p < 0.001$), but not for the other toys or sedentary alternatives. Seven girls and zero boys rated jump rope as their most liked toy. Eight boys and zero girls rated hockey as their most liked toy. Pearson correlations were computed to determine if prior exposure to the toys influenced children's liking of toys or physically active play. There were no significant correlations between the child's previous use of mini hockey and liking ($p > 0.2$) or rank ($p > 0.7$); toss-across and liking ($p > 0.8$) or rank ($p > 0.4$); skip it and liking ($p > 0.2$) or rank ($p > 0.09$); or jump rope and liking ($p > 0.4$) or rank ($p > 0.1$). There were no significant correlations between previous experience with a specific toy and total physically active play minutes (mini hockey, $p > 0.1$; toss-across, $p > 0.09$; skip it, $p > 0.1$; jump rope, $p > 0.2$). All children had previous experience with basketball, yielding no variability to test correlations.

As expected, the number of active toys the children played with increased ($p < 0.001$, Table 1) across each choice group. There was no gender difference ($p > 0.2$) in the number of toys children played with. There was, however, a gender difference ($p < 0.001$, Table 1) in the duration that boys (20.0 min) and girls (8.7 min) played with their most liked toy. Regardless of the number of toys available, boys played a consistent number of minutes with their favorite active toy while girls showed a 1.8-fold reduction in play time with their most liked toy as the number of active toy options increased.

As shown in the top panel of the Figure 1, boys engaged in 30% overall more ($p < 0.08$) play time than girls with the boys engaging in 1.3-fold longer active play than the girls in the no choice group. There were choice group ($p < 0.005$) effects for time spent in physically active play. Physically active play time was greater ($p < 0.01$) in the low choice (79%) and high choice (95%) groups compared to the no choice group. There was no difference ($p > 0.56$) in physically active play time between the low choice and high choice groups. Compared to access to no choice, providing access to low or high choice of active toys increased physically active play time, on average, by approximately 42% for boys and 190% for girls. There was no gender by group interaction detected ($p > 0.13$) for total minutes of physically active play.

There were also significant differences in the total number of MVPA bouts observed by choice group (middle panel, Figure 1). When compared to the no choice group, boys and girls increased their total MVPA bouts by 2.1 fold ($p < 0.002$) in the low choice group and by 1.9 fold ($p < 0.006$) in the high choice group. Boys had a greater number of total bouts across all choice groups ($p < 0.03$) when compared to girls. There was no gender by group interaction ($p > 0.98$) detected for total MVPA bouts. Bout durations of 15 sec, 30 sec, 1 min, 3 min and 5 min were also analyzed (Table 1). There were increases in the number of 30 sec bouts of MVPA across choice groups. Children in the low choice ($p < 0.0001$) and high choice ($p < 0.02$) choice groups had more 30 sec MVPA bouts when compared to the no choice group. No differences ($p > 0.1$) in number of 30 sec MVPA bouts were found between the 3-toy and 5-toy choice groups. There were no differences in gender or group in the number of 15 sec ($p > 0.1$), 1 min ($p > 0.09$), 3 min ($p > 0.1$) or 5 min ($p > 0.3$) bouts of MVPA.

There was a gender by group interaction ($p < 0.04$) for percent heart rate reserve (bottom graph, Figure 1). Boys in the no choice group had 5-fold greater percent heart rate reserve ($p < 0.05$) when compared to girls in the no choice group. As shown in the lower panel of Figure 1, providing choice of active toys increased boys' and girls' heart rates by 1.2-fold ($p > 0.4$) and 9-fold ($p < 0.003$) respectively. A similar trend is found using average heart rate adjusted for baseline heart rate (data not shown).

Average exercise intensity also increased with increasing toy choice (Figure 2). There were significant effects found for minutes spent in LPA and MPA, but not for VPA. Boys and girls in the low choice and high choice groups had decreases ($p < 0.02$) in time spent in LPA and increases ($p < 0.03$) in time spent in MPA, when compared to the no choice group. Combined, boys and girls in the low choice group had a 1.96 fold increase ($p < 0.05$) in minutes in MPA. Similarly, the high choice group had a 2.24 fold increase ($p < 0.02$) in minutes in MPA, when compared to boys and girls in the no choice group. No gender by group interactions were present for time spent in LPA ($p > 0.1$) or MPA ($p > 0.2$).

Discussion

Boys' and girls' physically active play and behavioral choices were measured under three different toy choice conditions. The results demonstrate that children who have access to a greater choice of active toys engage in nearly a 1-fold greater duration and 1.9-fold more MPA. There were also differential effects of choice on boys' and girls' physically active play and toy choices. Boys were less responsive to increases in the choice of active toys and their total physically active play time with their favorite toy changed little when presented with a choice of toys. In contrast, girls had a marked increase in total physically active play time and intensity and a reduction in physically active play time with their favorite toy. Even when given access to additional active toys boys continued to play with their most liked toy for 18 min, which is in sharp contrast to girls' 1.8-fold reduction in physically active play

time with their most liked toy when the number of active toy options increased. The boys' consistent time of physically active play with their favorite toy dampens the effect of choice on increasing physically active play time. However, girls engage in physically active play with their favorite toy less as choice increases so that choice becomes an important component of increasing their physically active play. Indeed, with increased choice girls' physically active play time and intensity of physically active play did not differ from boys. These results extend our understanding of the basic parameters that encourage or discourage physical activity. Girls, who are consistently less active than boys in general²⁰, can be motivated to engage in equal physical activity as boys by simply providing them with a greater choice of active toys. Boys' physically active play is less impacted by choice of toys when a favorite toy is present. Boys continue to engage in physically active play with their favorite toy when presented with choice.

Psychosocial factors may also help explain the gender difference in responsivity to increased active toy choice. The concept of 'need for cognition' attempts to explain tendencies of individuals to enjoy and engage in thinking.²¹ When examining factors within the 'need for cognition' scale, Tanaka, 1988²², found women scored higher than men in cognitive persistence, 'which is enjoyment in engaging in cognitive tasks. Extending this to the current study suggests that girls may enjoy the cognitive task of choosing toys, evaluating them, and selecting which to play with, whereas the selection process and thinking about the toys may be less appealing to boys. Girls may enjoy trying and exploring their options, whereas boys are more likely to immediately choose their most liked toy and play, thus diminishing the effect of choice on boys. However, in the limited research on need for condition in children, similar gender differences were not observed.²³

The selection of toys presented during the study may have also played a role in the effect of choice on active play. Boys prefer active and strategic play, whereas girls prefer creative and explorative play.²⁴ Given the purpose of the present investigation to study the effect of choice on active toy uses, the toys were more active than creative or explorative in design. This could have influenced the amount of time girls spent playing with a single active toy. However, these gender differences in play preferences seem to have been diminished by increasing the choice of toys, perhaps due to girls' 'need for cognition' and to explore the other active toys by playing with them. Alternatively, although great care was taken by the research team to reduce or eliminate potential bias from the actual toy selection, some children may have had gender stereotypes associated with specific toys. If a child perceived a toy was not suitable for play based on gender, they may have altered their behavior, thereby affecting the results. This is unlikely as the child's favorite toy was always available, and the toys used were gender-neutral.

The present investigation used a well controlled basic laboratory design and objective measurements of the amount and intensity of physical activity to isolate the effect of altering toy choice on active play. This laboratory research builds upon previous field research of children during recess, where observed physical activity increased with access to more games, equipment or markings. McKenzie and colleagues²⁵ found that children participated in greater physical activity during recess when play equipment was available than when no equipment was available. Verstraete and colleagues²⁶ also found an increase in children's physical activity during recess when presented with game equipment. Painted fluorescent markings, additional teacher presence and loose equipment have also been associated with increases in physical activity cross-sectionally and longitudinally.²⁷⁻²⁹

The present study also extends our research¹³ that used resistance training equipment as a model to test choice and found that the children completed a greater number of repetitions, lifted more weight total and had greater liking of the session when in a high choice versus a

no choice condition.¹³ However, this previous work did not note gender differences in response to altering the choice of activity options. This may be due to differences in exercise equipment utilized in each study. While the previous study used resistance training equipment, the current study used active toys that are more traditionally played with by children. The use of these active toys in the present study more closely resembles the types of physical activities children normally participate in, extending the generalizability of the present results beyond the previous study that was limited to weight training.

This study is not without limitations. First the data are limited by the small number of children in the study. Had there been more participants, we may have had enough power to detect an interaction between gender and group for LPA and MPA. Additionally, the children in the study were limited to a 132 sq ft observation room and were tested alone. Children may have changed their total minutes of play, intensity of play or toy choices if they had more space or had a friend with whom to play. Discussions have emerged regarding whether 3 or 4 METS are a more appropriate cut point for children.³⁰ The results presented are based on LPA, MPA and VPA published equations and cutpoints for children, where MPA is defined as 3–5.9 METS.¹⁷ This may be seen as a potential limitation of the study.

Future research should investigate the effect of choice on children's physically active play when children have a peer present. Additionally, the optimal ratio of choice of toys to time with the toys, for the encouragement of maximal physical activity, remains unknown. Finally, in order to generalize these findings to more real-life applications, the effect of choice should be tested with more motivating sedentary alternatives typically available to youth. Highly reinforcing alternatives such as video games or television may reduce or alter the results from the current study.

Conclusion

In conclusion, adding a choice of active toys to a child's environment for one hour increased the duration and intensity of physically active play. Children were active for more total minutes and had more minutes of intense play when presented with a choice of toys. The effect of choice on increasing minutes of physical activity was greater in girls than boys. This study extends previous research of the basic factors that influence physical activity behavior by showing that increasing the choice of traditional active toys available to a child is likely to increase their total physical activity.

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Practical Implications

- Adding a choice of active toys to a child's environment for one hour increases the duration and intensity of their physical activity.
- The effect of choice has a greater effect of increasing physical activity on girls than boys.
- Girls can be motivated to engage in equal physical activity as boys by providing them with a greater choice of active toys.

Figure 1.

Minutes of physically active play (upper panel), number of 30 sec MVPA bouts (middle panel) and percent heart rate reserve (lower panel) of boys and girls given access to one, three, or five active toys during a one-hour free choice session. Data are mean $\pm$ SE. Like letters are $p < 0.05$.

Figure 2.

Minutes of physically active play in light physical activity (LPA), moderate physical activity (MPA), and vigorous physical activity (VPA) by gender. Data are mean $\pm$ SE. Like letters are $p < 0.05$.

Table 1

Demographics, physical characteristics and physically active play variables by gender and choice groups

	1 active toy		3 active toys		5 active toys	
	Boys <i>n</i> = 6	Girls <i>n</i> = 6	Boys <i>n</i> = 6	Girls <i>n</i> = 6	Boys <i>n</i> = 6	Girls <i>n</i> = 6
Age (y)	10.3 ± 1.4	10.7 ± 1.8	11.0 ± 1.1	9.0 ± 0.9	10.8 ± 1.3	10.0 ± 1.1
Weight (kg)	40.3 ± 8.2	37.2 ± 8.9	40.2 ± 9.7	34.64 ± 7.7	37.5 ± 9.3	39.0 ± 4.8
Height (cm)	145.1 ± 11.9	146.3 ± 14.6	147.0 ± 8.8	139.6 ± 11.6	147.6 ± 10.3	147.9 ± 4.5
BMI %ile	72.6 ± 19.5	42.7 ± 16.2	58.2 ± 27.6	58.3 ± 28.8	41.4 ± 29.3	56.9 ± 17.4
SES	45 ± 9	52 ± 10	47 ± 4	47 ± 11	50 ± 12	47 ± 12
Number of toys used ^a	1.0 ± 0	0.8 ± 0.4	3.0 ± 0.0	2.5 ± 0.5	4.0 ± 1.1	4.0 ± 0.6
Min with favorite toy ^b	24.7 ± 11.6	11.7 ± 8.8	17.8 ± 6.3	10.3 ± 8.8	17.5 ± 12.3	4.2 ± 1.3
Total bouts at MPA ^a	14.8 ± 8.9	7.0 ± 6.9	26.7 ± 4.8	19.8 ± 10.0	24.7 ± 11.5	18.2 ± 7.6
Number of 15 sec bouts at MPA	5.5 ± 4.0	5 ± 5.5	11.1 ± 4.4	6.3 ± 2.8	9.5 ± 6.5	7.3 ± 3.8
Number of 30 sec bouts at MPA ^a	4.0 ± 3.4	1.2 ± 1.3	10.8 ± 4.8	8.0 ± 5.7	8.0 ± 5.4	5.7 ± 3.1
Number of 1 min bouts at MPA	3.8 ± 4.8	0.5 ± 0.8	4.2 ± 1.6	4.5 ± 2.6	5.5 ± 3.3	3.5 ± 2.1
Number of 3 min bouts at MPA	1.0 ± 0.9	0.3 ± 0.8	0.3 ± 0.5	0.6 ± 0.8	1.0 ± 1.0	1.3 ± 1.2
Number of 5 min bouts at MPA	0.5 ± 0.8	0 ± 0	0.2 ± 0.4	0.3 ± 0.5	0.7 ± 1.2	0.3 ± 0.5
Minutes LPA ^a	41.3 ± 13.9	56.7 ± 3.8	41.2 ± 8.0	38.7 ± 9.0	33.5 ± 13.2	39.8 ± 9.8
Minutes MPA ^a	15.8 ± 15.3	2.3 ± 2.1	17 ± 6.3	18.7 ± 9.2	23.2 ± 12.5	17.5 ± 9.2
Minutes VPA	2.8 ± 3.3	1.0 ± 2.4	1.8 ± 3.0	2.7 ± 2.3	3.3 ± 3.4	2.7 ± 2.3

Data are mean ± SD

SES: socioeconomic status. An SES of 40 through 50 is equivalent to medium size business owners, minor professionals and technical jobs, such as computer programmers, real estate agents, sales managers, social workers and teachers. SES is a composite score of occupation and education that can range from 8–66.

^a significant ($p < 0.05$) across choice group

^b significant ($p < 0.05$) gender difference