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Three field experiments were conducted to determine the effects of different recess timing regimens on children's classroom and recess behaviors. Experiment 1 involved children in Grades K, 2, and 4. The timing of their recess was experimentally varied by 30 minutes. Students' classroom behavior before and after recess was observed as was their outdoor recess behavior. Children's prerecess inattention varied as a function of deprivation duration. Further, children, but especially boys, were more socially interactive on the playground following the long deprivation, compared to the short deprivation. Recess behaviors did not relate significantly to postrecess inattention. However, inattention rates were higher before recess than after. Experiment 2 utilized a similar paradigm with a sample of second and fourth graders from the same school. Experiment 2, generally, replicated results from Experiment 1. In Experiment 3, which utilized a replication sample design, children's recess was also manipulated, but the recess period was indoors. Results of the two samples replicated each other and the preceding experiments. Results are discussed in terms of play deprivation theory and massed versus distributed practice.

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The recess period is one of the few places in elementary school children's day where they can interact with peers on their own terms. Seeing the value in this natural laboratory of peer interaction, child psychologists and educators have considered the school playground as an important venue for children's social and cognitive development (Blatchford, 1988; Hart, 1993a; Pellegrini & Smith, 1993; Sutton-Smith, 1987, 1990, 1992). Research has only just begun to document the ways in which children learn and practice important social cognitive skills on the elementary school playground (Boulton & Smith, 1993; Ladd & Price, 1993; Pellegrini, 1992; Sutton-Smith, 1990).

Our knowledge of children's recess playground behavior, however, remains quite limited (Hart, 1993a). Generally, researchers have examined children's playground behavior with little regard for the larger school context in which recess periods are embedded. One important aspect of context that has only been marginally studied is the timing within the school day of the recess period. For example, some schools have a short recess period every 40–45 minutes (Stevenson & Lee, 1990), while others have one recess in the afternoon of each day (Blatchford, 1988). Such variation in recess period timing has an impact on children's classroom and playground behavior. Following the notion of massed versus distributed practice (Ebinghaus, 1885/1964; Toppino, Kasserman, & Mrack, 1991), children learn best when their efforts are distributed across tasks (Pellegrini & Davis, 1993; Stevenson & Lee, 1990). Further, children are more physically active and socially interactive on the playground after longer, compared to shorter, confinement periods (Pellegrini & Davis, 1993; Smith & Hagan, 1980). These breaks and behaviors, in turn, may have implications for children's behavior when they return to the classroom after recess (Pellegrini & Davis, 1993; Stevenson & Lee, 1990) as well as for their more distal social cognitive development (e.g., Hart, 1993b; Ladd & Price, 1993).

In the present study, we examined ways in which recess timing affected children's behavior on the school playground at recess as well as their attention to school tasks before and after recess. By recess timing, we mean the amount of time before recess that children experience sedentary activities (or are deprived of social and physical play) that typify most primary school classrooms (Minuchin & Shapiro, 1983). Play deprivation theory (Burghardt, 1984, 1988; Fagen, 1981; Smith & Hagan, 1980) predicts that duration of the confinement period immediately before recess should result in a *rebound* (i.e., increased levels of those behaviors of which children were deprived). Postdeprivation activity rebounds have been observed in the animal literature (in domestic goats, *Capra hirus* [Chepko, 1971], and black-tailed deer, *Odocoileus hemionus* [Muller-Schwarze & Muller-Schwarze, 1982]) and in small samples of British preschool (Smith & Hagan, 1980) and American primary school children (Pellegrini & Davis, 1993).

The reasoning behind the play deprivation-rebound hypothesis is as follows. Childhood is a period during which social skills and cardiopulmonary functions are developed and exercised (Fagen, 1981; Smith & Hagan, 1980). Given opportunity, young children engage in social and physically vigorous

behaviors (Fagen, 1981; Smith & Hagan, 1980) which develop these functions. If deprived of these opportunities, they will later compensate, or rebound, with increased levels of physical activity and social interaction when given the chance.

Extant research suggests that children's gender and grade level may interact with deprivation effects on these behaviors. Boys are, generally, more physically active than girls (Eaton & Enns, 1987); however, Smith and Hagan (1980), in their study of British preschool children, found no gender effects on vigorous playground behavior, suggesting that gender differences for this sort of physical activity may appear later during the primary school years. Consistent with this explanation, Pellegrini and Davis (1993) found gender differences in the vigorous play of a group of American third graders.

Age, and its proxy grade level, also is relevant to the ways in which children rebound from deprivation. Older, compared to younger, children should rebound from deprivation with social interaction and physical activity, because they have the requisite social cognitive skills (Ellis, 1984) and because playground behavior is often expressed through physically vigorous social games (Sutton-Smith, 1990, 1992). To test this developmental hypothesis more directly, we examined the extent to which short and long deprivations before recess affected the playground physical activity and social interaction of boys and girls across the primary school grades: Grades K, 2, and 4 in Experiment 1 and Grades 2 and 4 in Experiment 2.

During the deprivation period, or that period immediately preceding recess, children's inattention to instructional tasks should increase as a function of duration of the deprivation period (Bjorklund & Harnishfeger, 1990; Burghardt, 1988; Stevenson & Lee, 1990). While this issue has not been directly studied, anecdotal evidence from Japan and Taiwan, as well as the massed versus distributed practice literature (Ebinghaus, 1885), suggests that children's attention to class work is maximized when instructional periods are relatively short, not long, and intense.

Finally, we examined the relation between playground behavior and postrecess behavior in the classroom. We hypothesized that children's attention to the postrecess seat work task should be positively related to their levels of physical activity and social interaction at recess. The reasoning here is that, at recess, children are rebounding from their previous deprivation; recess thus provides children with the opportunity to engage in motivating forms of social interaction and physical activity. These recess behaviors, also, provide a change from cognitively demanding class work. Research suggests that providing children with breaks from cognitively demanding tasks facilitates cognitive performance (Bjorklund & Harnishfeger, 1990). The degree to which they do that at recess should relate to attention on the postrecess task. While Stevenson and Lee (1990) present a similar argument, they do not present empirical data specific to this issue.

The one study to directly address this issue of recess activity and postrecess attention (Pellegrini & Davis, 1993) found the opposite: Boys' level of physical activity on the playground was related to postrecess inattention.

These results may have been due to the fact that boys were less attentive because they worked on female-preferred tasks. In the present study, gender preference of tasks before and after recess was experimentally manipulated.

The present study utilized a field experimental design (Kerlinger, 1973) that manipulated experimental conditions (recess timing) in children's primary school classrooms. In Experiments 1 and 2, children were observed in outdoor recess, while, in Experiment 3, they were observed during indoor recess. Experiments 1 and 2 were designed as separate literal replications (Lykken, 1968) of each other, while Experiment 3 had a replication sample built in. The benefits of these features, in terms of internal, external, and ecological validity, have been forcefully argued by Bronfenbrenner (1979), McCall (1977), and Smith and Connolly (1980).

Experiment 1

In Experiment 1, we were able to manipulate recess timing at each of three grade levels (K, 2, and 4). Only in the latter two grades, because of curriculum constraints, were we able to manipulate prerecess and postrecess activities. We first examined the effects of confinement duration on the playground behavior of boys and girls in Grades K, 2, and 4. Second, we examined the ways in which boys and girls attended to classroom tasks immediately before and after recess. For these analyses, kindergarten data were analyzed separately from second- and fourth-grade data. For the older children, we could determine the extent to which gender preference of the prerecess and postrecess tasks affected children's task inattention.

Method

Subjects

The children in this experiment all attended a public elementary school in the southeastern United States. Three intact classrooms participated in the study: Kindergarten, Grade 2, and Grade 4. There were 17 children (11 boys and 6 girls) in Kindergarten, 24 in second grade (13 boys and 11 girls), and 21 in fourth grade (10 boys and 11 girls); the average age of the children at each grade was: 5.6 years, 7.5 years, and 9.7 years, respectively. The children represented a variety of social, economic, and cultural backgrounds; approximately one third of the children were African American, very few were Asian Americans, and the majority were European Americans.

Procedure

Four days per week (Monday through Thursday), the duration of children's prerecess classroom work was manipulated in each of the three grades such that twice weekly children went to recess at 10:00 AM (short deprivation) and twice weekly they went to recess at 10:30 AM (long deprivation); order of deprivation was counterbalanced across days and grade levels. Additionally, on each day, children in Grades 2 and 4 were presented with either a

male-preferred or a female-preferred task immediately before recess (i.e., prerecess) and immediately after recess (i.e., postrecess). Teachers in Grades 2 and 4 read children a male-preferred story before and after recess or a female-preferred story before and after recess. Gender-preference was determined by the gender of the main character in the stories. Children were expected to sit quietly in their seats during this time.

For kindergartners, the prerecess and postrecess regimens differed, though the manipulated prerecess durations were the same as for other grades. Kindergartners worked at various interest centers within the classroom, such as the art center, the silent reading center, the math center, and so forth. Children were free to choose the center in which to interact. Once at the center, at the beginning of the prerecess observations, they were expected to work for the whole prerecess observation period. The main difference between the kindergarten prerecess and postrecess activities and those of second- and fourth graders was that the former could choose a prerecess activity. For all grades, however, children were engaged in quite sedentary activities.

Observational Methods

Each child was observed on each of the experimental days (Monday through Thursday) for 2 months during the prerecess, recess, and postrecess periods. Each of the three periods lasted 20 minutes. A total of four observers, blind to the purposes of the study, were used; there were three regular observers and one rotating observer whose primary job was to be a reliability judge. Three of the observers were graduate students, and one was a partner of a graduate student.

Preliminary Observations

There was a preliminary observational phase of one month before actual data collection began during which the observers were trained in the following ways. In the first session, the authors gave copies of the observational checklists to the observers for explication and discussion. During this session, videotapes of prerecess, recess, and postrecess periods were viewed, reviewed, discussed, and coded. Also during this session, observers were given individually labeled pictures of children in the classrooms so that they could learn the names of the children in each class.

In the course of the next 4 weeks of the preliminary observation phase, observers were in the target classrooms and on the playground conducting practice observations. The purposes of this portion of the preliminary phase were to provide additional opportunities to learn children's names, become facile and reliable with the checklists, and to provide the children an opportunity to get used to the observers. Sample observational data were collected according to the same schedule and rules as those used during the actual data collection. During each of these 4 weeks, the authors and the observers met to review videotapes and check sample observations. Additional video-

taped behaviors were shown, independently coded, and then discussed. At the end of this preliminary phase, the actual observation period began.

Observations for Data Collection

Observations followed scan sampling/instantaneous recording rules (Pellegrini, in press) in each setting. Specifically, each child within a classroom was observed in each of the three periods (i.e., prerecess, recess, and postrecess) on each observation day. Children were observed an average of 21 times in each of these periods. A different child's behavior was scored instantaneously every 30 seconds across each period. By instantaneous recording, we mean that, when observers' watches displayed 30 seconds, behavior was recorded; preceding and succeeding behaviors within the 30-second interval were not considered. Digital watches were used by each observer to mark the 30-second intervals. Time interval order was counterbalanced within classrooms and within periods. Using this procedure, each child was observed in each of the 30-second intervals for prerecess, recess, and postrecess.

Behavioral Codes

There were two sets of behavioral codes used: One was used for indoor behavior—that is, prerecess and postrecess—and one for outdoor behavior—that is, recess. These behaviors were listed and recorded on checklists. The checklists were designed so that each child had a separate checklist for each day; separate sections, and corresponding behaviors, were dedicated to the prerecess, recess, and postrecess periods. For the indoor observations, inattention was coded. For outdoor behavior, physical activity and social interaction were coded. Additionally, observers recorded approximate temperature outdoors at the time of the recess and whether the weather was clear or wet. The average temperature was 42 degrees Fahrenheit (SD = 8.0).

Inattention was determined by the direction of the child's gaze (Pellegrini & Davis, 1993). Inattention was coded if they were not looking directly at the teacher during the book reading/listening sessions; for kindergartners, inattention was coded if they did not look directly at the activity, a peer in that activity, or the teacher if she was in the center or talking to the child/class. Gaze is a simple, but reasonable, criteria for inattention (Pick, Frankel, & Hess, 1975). The unit of analysis was the relative frequency of inattention scores.

Physical activity was coded along a 9-point ordinal scale developed by Eaton, Enns, and Presse (1987). The 9-point scale was based on a 3 × 3 matrix. Three sections corresponded to stature (lying down, sitting, or standing); each of these stature sections was then scored along a 3-point continuum from low to high. Scores of 1–3 were for lying down, 4–6 for sitting, and 7–9 for standing. For example, a score of one would be lying down/low movement (such as, lying down looking at the teacher) whereas a score of 9 would be running across the playground. This measure has been used extensively by

Eaton and colleagues (Eaton, Enns, & Presse, 1987) and correlates significantly with actometer (i.e., mechanical recording device) readings.

Social interaction was defined as any instance where communication, verbal or nonverbal, was observed between children; thus, verbal interactions as well as reciprocated gazes were coded as social (Pellegrini & Davis, 1993). The unit of analysis was the relative frequency of social interaction scores.

Reliability

Reliability considerations for the behavioral measures, as noted above, began with a preliminary observation training phase. After that time, retraining/checking sessions took place every 2 weeks. These sessions were held so that observers and authors could discuss coding problems and review and code tapes of observations made in the field.

Throughout the data collection phase, one of the four observers acted as a reliability judge, by rotating among the other observers. The result was that each observer was checked once per week across the duration of this experiment. The reliability checker was blind to the hypotheses of the study; an interobserver reliability statistic, Cohen's kappa, was calculated for each of the measures. All kappa coefficients were above the level of .60 and thus considered "excellent" by Landis and Koch's (1977) criteria. The individual coefficients are listed in Table 1.

Experiment 1 Results/Discussion

Because the prerecess and postrecess periods were organized differently in kindergarten, compared to the second- and fourth grades, the analyses for these two periods were conducted in the following way: We analyzed the kindergarten prerecess and postrecess data in terms of the effects of gender and condition (long and short confinement) on prerecess and postrecess inattention. Gender was a between-subjects variable, and condition was a within-subjects variable. For the second- and fourth grades, two additional factors were added to the design: Grade was added as a between-subjects variable, and gender-preference of the prerecess task (2: male- and female-preferred) was added as a within-subjects variable. Repeated measures analyses of variance (ANOVA) were calculated on prerecess inattention. For the

Table 1

Reliability Coefficients for Experiment 1 Behavioral Measures

	Prerecess and postrecess	Recess
Physical activity		.86
Social		.79
Inattention	.75	

recess data, comparisons across all three grades were made such that the effects of grade (3), gender (2), and condition (2) on recess physical activity and social interaction were analyzed. Hypotheses were tested with one-tailed tests. All post hoc comparisons were made using Student's Newman-Keuls procedure.

Prerecess Analyses

Descriptive statistics for prerecess inattention are presented in Table 2. For the kindergarten prerecess inattention measure, a significant main effect for condition was observed, $F(1, 15) = 3.64$, $p < .03$, such that children were less attentive during the long, compared to the short, confinement period. The effect for gender approached significance, $F(1, 15) = 2.49$, $p < .06$, with boys being less attentive than girls.

For the second- and fourth grade prerecess analyses on inattention, there was a statistically significant main effect for grade, $F(1, 41) = 19.11$, $p < .0001$, but it was mediated by a significant condition X grade interaction, $F(1, 41) = 4.35$, $p < .02$. For second graders, there was no significant effect for confinement, but, for fourth graders, children were less attentive during the long, compared to the short, confinement period. A significant task X gender interaction, $F(1, 41) = 4.86$, $p < .01$, was also observed; girls exhibited higher levels of inattention than boys in the male-preferred task.

The prerecess results supported the suppositions of Stevenson and Lee (1990); children are less attentive during long, compared to short, work periods. Kindergarten children were more attentive during the short confinement period than during the long period. For older children, condition interacted with grade such that fourth graders were less attentive during the longer confinement period than during the shorter period. More generally, however, second graders were less attentive than fourth graders. This grade X condition interaction supports earlier work suggesting that attention to

Table 2

Experiment 1: Descriptive Statistics for Prerecess Inattention

	Long confinement				Short confinement			
	Male-Prefer		Female-Prefer		Male-Prefer		Female-Prefer	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Kindergarten								
Boys	.56	.44	.67	.33	.23	.40	.39	.45
Girls	.27	.43	.28	.44	.14	.34	.27	.42
Second grade								
Boys	.86	.26	.80	.35	.86	.26	.89	.26
Girls	.85	.29	.78	.39	.92	.08	.76	.38
Fourth grade								
Boys	.60	.41	.76	.34	.38	.48	.55	.51
Girls	.73	.40	.62	.41	.66	.37	.38	.40

school tasks increases with age (Wittrock, 1986). Further, the task X gender interaction reinforces the notion that attention to school tasks is influenced both by task-level variables, such as gender preference, and child-level variables, such as age and gender. This finding is consistent with the extant gender preference for stories literature (Monson & Sebesta, 1991).

Recess Analyses

Analyses of the recess data were conducted with a grade (3) X gender (2) X condition (2) repeated measures ANOVA, with the last factor being repeated. The dependent measures were physical activity and social interaction. The descriptive statistics for these analyses are displayed in Table 3.

Regarding the physical activity measure, main effects were observed for grade, $F(2, 56) = 4.92, p < .0005$, and gender, $F(1, 56) = 10.26, p < .0001$. Post hoc analyses revealed that fourth graders were significantly more active than other children and boys were more active than girls. For the social interaction category, main effects were observed for grade, $F(2, 56) = 18.03$, $p < .0001$, and condition, $F(1, 56) = 44.88$, $p < .0001$. Additionally, a significant grade X condition interaction was observed, $F(2, 56) = 7.30$, $p < .0001$; within the long confinement condition, fourth graders were significantly more social than were second graders.

Outdoor temperature was positively and significantly correlated with both physical activity, $r = .48$, $p < .0001$, and social interaction, $r = .49$, $p < .0001$ ($N = 62$).

Consistent with the hypotheses, an effect for condition was observed on social interaction: Fourth graders were more socially interactive after the long, compared to the short, periods. These results can be explained in terms of children's rebounding from deprivation through some form of social interaction after a period of being deprived of that sort of interaction. That primary school children's playground behaviors are more social and rule-

Table 3
Experiment 1: Descriptive Statistics for Recess Behavior

	Activity				Social interaction			
	Short		Long		Short		Long	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Kindergarten								
Boys	7.34	1.47	7.05	2.62	1.10	.79	1.97	.71
Girls	6.46	2.44	6.91	2.13	1.24	.66	1.78	.90
Second grade								
Boys	6.96	1.18	6.87	1.34	1.36	1.05	1.43	.84
Girls	6.56	1.65	6.82	1.48	1.40	1.00	1.56	.89
Fourth grade								
Boys	7.95	1.11	8.02	.82	1.60	.80	2.42	1.02
Girls	7.46	1.22	6.66	1.80	1.56	.89	2.08	.83

governed than vigorous (Pellegrini, 1990; Sutton-Smith, 1990) reinforces the primacy of social interaction for primary school children.

The lack of a condition effect on physical activity is inconsistent with deprivation theory and counter to previous research with primary school children (Pellegrini & Davis, 1993). This inconsistency may have been due to climate differences. The earlier study was conducted during the warm, spring months, while the present study was conducted during the winter, when the average temperature was 42 degrees Fahrenheit, cold for the southeastern United States. It may have been the case that children were active in the colder months in an effort to generate body heat (Burghardt, 1988). Such an argument is supported by general relations between climate and behavior (e.g., Cullumbine, 1950) as well as the reported positive correlations between physically vigorous playground behavior and temperature in another study (Smith & Hagan, 1980); anecdotal observations reported in the literature tell a similar story (e.g., Naylor, 1985).

Gender effects were observed on the physical activity measure at recess, replicating the results of earlier studies of elementary school children's physical play at recess (Pellegrini & Davis, 1993), as well as the results of studies of more general gender difference in activity (Eaton & Enns, 1987).

Postrecess Analyses

The postrecess analyses involved correlating recess behaviors with classroom inattention to seat work after recess. Correlation coefficients were calculated between the recess physical activity and social interaction scores and the postrecess inattention measure across the three grade levels; the correlations were not statistically significant (respectively, $r = .05$ and .01, $N = 62$).

To test the massed versus distributed practice hypothesis, we measured the difference between inattention to tasks before and after recess with a 2 (grade) X 2 (prerecess/postrecess) repeated measures ANOVA. The significant effects for grade, $F(2, 32) = 14.47$, $p < .0001$, and difference between prerecess and postrecess attention were observed, $F(1, 32) = 33.70$, $p < .0001$, and were mediated by a grade X difference interaction, $F(1, 32) = 13.19$, $p < .0001$. Inattention to task was also significantly greater before recess than after recess at Grades 2 ($M = 14.83$ and 6.44, respectively) and 4 ($M = 9.15$ and 7.45, respectively) but not for Kindergarten ($M = 4.3$ and 3.5). Postrecess analyses suggest that providing a break from seat work maximizes attention. Behavior during the break period, however, was not implicated in postrecess attention.

Results from this experiment should be interpreted cautiously primarily because of the small sample size and because there was only one classroom at each grade level. Replication is clearly needed to assure that the results are not aberrational (Lykken, 1968). Replication is also needed to clarify the effect of condition on physical activity at recess; the results from this experiment were not consistent with the one other experiment involving primary

school children. The positive and significant correlation between outdoor temperature and physical activity may have been responsible for these results.

With these needs in mind, a second experiment was designed.

Experiment 2

Experiment 2 was designed as a literal replication (Lykken, 1968) of Experiment 1. We attempted to replicate the deprivation effects on Grade 2 and Grade 4 children's prerecess inattention to classroom tasks and deprivation effects on recess behavior. This study was conducted in the winter, 1 year after Experiment 1.

Method

Subjects

The children in this experiment attended the same school as those in Experiment 1. The sample consisted of 22 second graders (12 boys and 10 girls) and 15 fourth graders (5 boys and 10 girls). Demographically, these children were similar to those in Experiment 1, being predominantly European American and about one-third African American.

Procedure

As in Experiment 1, children's recess period was manipulated 4 times weekly, Monday through Thursday. The time of day and the duration of prerecess confinement was the same as in Experiment 1. Recess periods occurred either at 10:00 A.M. or 10:30 A.M., in counterbalanced order. Also like Experiment 1, children were read the same male- or female-preferred stories during the pre- and postrecess periods. Children were observed pre- and postrecess, as well as during recess.

Observational Measures

Scan sampling, instantaneous recording rules were followed for prerecess, recess, and postrecess periods. Individual children in the class were observed at 30-second time intervals during the recess, prerecess, and postrecess periods daily. Each child was observed in counterbalanced order such that he or she was observed (on the average of 19 times) in each of the 30-second intervals in each of these periods. The behavioral measures utilized in Experiment 1 were also used in Experiment 2 for the three periods; these measures and the corresponding reliability coefficients are presented in Table 4.

Reliability. Two observers conducted concurrent observations for all three periods, at least once per week, for the duration of the experiment, and reliability checks were made by a separate judge. The kappas were all above the .60 level, and therefore considered excellent by Landis and Koch (1977); they are displayed in Table 4.

Table 4
Reliability Coefficients for Experiment 2 Behavioral Measures

	Prerecess and postrecess	Recess
Physical activity	.93	.89
Social	.88	.85
Inattention	.72	

Experiment 2 Results/Discussion

Prerecess Analyses

The prerecess analyses tested the effects of grade (2), gender (2), condition (2), and task (2) on children's inattention to a task with a repeated measures ANOVA, where the last two factors were within-subjects variables; one-tailed tests were utilized. Descriptive statistics for these data are displayed in Table 5.

Significant main effects for grade, $F(1, 33) = 5.86$, $p < .01$, and task were observed, $F(1, 33) = 4.20$, $p < .02$. Grade, however, interacted with condition and gender, $F(1, 33) = 2.66$, $p < .05$, such that fourth-grade boys', not girls', inattention scores were higher in the long, compared to the short, condition. Grade and condition also interacted with task, $F(1, 33) = 18.27$, $p < .0001$, indicating that the female-, compared to the male-, preferred task elicited higher levels of inattention except for fourth graders in the long confinement condition.

Recess Analyses

The next series of analyses examined the effects of grade (2) X gender (2) X condition (2) on children's physical activity and social interaction at recess. Separate repeated measures ANOVA were calculated for each of the depen-

Table 5
Experiment 2: Descriptive Statistics for Prerecess Inattention

	Long				Short			
	Male-Prefer		Female-Prefer		Male-Prefer		Female-Prefer	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Second grade								
Boys	.21	.10	.54	.48	.74	.35	.11	.01
Girls	.20	.11	.82	.29	.65	.35	.11	.10
Fourth grade								
Boys	.54	.50	.93	.10	.51	.47	.54	.49
Girls	.24	.40	.60	.43	.35	.46	.41	.44

dent measures; the last factor was a within-subjects variable, and one-tailed tests were employed. The descriptive statistics for these analyses are displayed in Table 6. For the physical activity measure, grade, F (19, 33) = 49.19, $p < .0001$, and condition effects were observed, F (1, 33) = 3.21, $p < .04$. Fourth graders were more physically active than second graders, and all children after the long, compared to the short, periods were more physically active. Regarding social interaction, grade, F (1, 33) = 7.93, $p < .0001$, and condition, F (1, 33) = 12.30, $p < .0001$, again, had significant main effects. Social interaction increased with grade level and with length of previous class work periods. Grade, however, interacted with gender and condition, F (1, 33) = 3.68, $p < .03$. Social interaction increased across grade for boys in the long, not short, condition; for girls, too, the grade-related increase was only observed after the long condition.

Lastly, correlations between social interaction and physical and ambient temperature during the recess period were calculated; the correlations, respectively, were $r = .62$, $p < .0001$, and $r = .51$, $p < .0001$ ($N = 37$). The average temperature for the period was 48.2 degrees Fahrenheit ($SD = 8.5$).

Postrecess Analyses

Postrecess analyses involved correlating postrecess task inattention scores to levels of recess social interaction and physical activity. The relation between physical activity was not significant, while the relation between social interaction and inattention was positive and significant, $r = .39$, $p < .005$ ($N = 37$). The difference between prerecess and postrecess inattention was examined at each grade level with a repeated measures ANOVA. A significant difference, F (1, 15) = 3.35, $p < .04$, between prerecess ($M = 5.66$) and postrecess ($M = 3.88$) was observed for second grade only, not for fourth grade ($M = 6.60$ and 6.20, respectively).

The results from this experiment, like those from Experiment 1, suggest that children's task inattention is affected by recess timing and that timing interacts with dimensions of the task as well as children's age and gender.

Table 6
Experiment 2: Descriptive Statistics for Recess Behavior

	Activity				Social interaction			
	Long		Short		Long		Short	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Second grade								
Boys	3.72	4.02	4.27	3.92	.68	.81	.75	.90
Girls	4.77	3.85	4.85	3.85	.97	1.02	1.00	.90
Fourth grade								
Boys	8.00	.90	7.42	1.44	2.05	.46	1.30	.48
Girls	7.51	1.30	6.80	2.52	1.60	.77	1.32	.72

Correspondingly, duration of prerecess class time affected children's level of social interaction at recess. Children's recess behavior, especially that of boys, tended to be more social and physically active with age. Recess behavior was, generally, not related to postrecess task attention in either experiment. Again, like Experiment 1, however, children exhibited higher levels of inattention before recess than after recess. The positive and significant relation between outdoor temperature and children's recess behavior was replicated. As noted above, this probably relates to children's efforts to generate body heat.

Experiment 3

The preceding experiments left unresolved the ways in which temperature affected recess behavior; in both experiments, physical activity on the playground was significantly related to outdoor temperature. Cold temperatures seemed to maximize children's physical activity and, correspondingly, the extent to which they explored the outdoor environment.

In Experiment 3, we utilized the same play deprivation paradigm with two groups of fourth graders; their recess, however, was indoors, where the temperature was held constant. We were interested in the effect of deprivation on indoor recess behaviors and the ways these behaviors related to postrecess task inattention. In this experiment, however, a replication sample design (Smith & Connolly, 1980) was employed. That is, the same experiment was conducted with two separate intact classrooms. Such a design was chosen because of the relatively small samples involved in each classroom and because of the interdependence of social behavior within each classroom. This procedure guards against Type I error associated with this sort of sample.

Method

Subjects

Children in this experiment were drawn from two fourth-grade classrooms in the same school as children in Experiments 1 and 2. In Classroom 1, there were 10 boys and 11 girls, and, in Classroom 2, there were 7 boys and 16 girls. The average age of the children was 10.1 years.

Procedure

Exact procedures were followed in each classroom. Children's recess period was manipulated 4 times weekly, Monday through Thursday. Recess periods were held at either 10:00 A.M. or 10:30 A.M. in counterbalanced order for the entire experimental period. Teachers also read the same male- and female-preferred books to children before and after recess. During prerecess and postrecess periods, children were expected to sit quietly at their seats while the teacher read to them. Children's recess periods, however, were held indoors; the average room temperature was 69 degrees Fahrenheit. During

this 20-minute recess period, children could move freely around the room and interact socially with peers.

Observational methods. Observations were conducted by three trained observers, some of whom were utilized in Experiments 1 and 2. For prerecess and postrecess periods, children were observed, as in Experiments 1 and 2, according to scan sampling, instantaneous recording rules. Children were observed (on the average of 22 times in each period), in counterbalanced order, in 30-second intervals before and after recess, and their inattention was coded on postrecess tasks.

For the recess period, however, observation rules differed for Experiment 3; focal child sampling and continuous recording rules (Pellegrini, in press) were used for 30-second intervals. Children were observed (on the average of 22 times), in counterbalanced order, in each of the twenty-two 30-second intervals across the recess period. In this procedure, physical activity and social interaction, as in Experiments 1 and 2, were coded; additionally, the variety of physical locations in the classroom sampled by each child during the entire 30-second period was scored. The variety of location measure was derived by dividing the classrooms into six equal space units. The unit of analysis was the average number of locations visited/observation period.

Reliability. Reliability was established by weekly checks by a third observer. The high rates of agreement reported earlier were maintained for the classroom and recess measures (kappa = .86). Reliability for the variety of location measure was .95.

Results/Discussion

Recess Analyses

The descriptive statistics for recess physical activity, social interaction, and variety of locations visited are presented in Table 7. First, regarding the effects of gender and condition on physical activity for Classroom 1, a significant

Table 7

Experiment 3: Descriptive Statistics for Indoor Recess

	Activity				Social interaction				Variety locations			
	Short		Long		Short		Long		Short		Long	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Class 1												
Boys	5.35	1.39	5.70	1.25	1.52	.9	1.55	.86	2.20	.60	2.40	.55
Girls	4.97	1.10	4.70	1.52	1.70	1.07	1.57	.87	1.57	.55	1.90	.54
Class 2												
Boys	3.15	2.60	3.67	2.36	1.20	1.11	1.20	1.00	.94	.82	1.15	.85
Girls	2.70	2.57	3.15	2.26	1.05	1.15	1.02	1.12	.77	.70	.92	.75

effect for gender was observed, $F(1, 19) = 3.83, p < .03$, with boys being more active than girls. Gender, however, interacted significantly with condition, $F(1, 19) = 3.86, p < .03$, such that boys were more active than girls after the long period. Regarding Classroom 2, main effects were observed for gender, $F(1, 21) = 2.82, p < .05$, such that boys were more active than girls. A main effect was also observed for condition, $F(1, 21) = 4.96, p < .01$: Children were more active after the long condition. Thus, in both experiments, children's physical activity was greater after long confinement, and boys were more active than girls.

For the social interaction measure, no effects were observed in either Classroom 1 or 2. Regarding the variety of locations measure in Classroom 1, a main effect for condition was observed, $F(1, 19) = 9.54, p < .003$, with more locations being visited after the long confinement period. In Classroom 2, main effects for gender, $F(1, 21) = 3.23, p < .04$, and condition, $F(1, 21) = 9.06, p < .003$, were observed with more locations being visited by boys. Condition effects on location were also found and thus replicated in both samples of this experiment.

The relations between recess behaviors (i.e., physical activity, social interaction, and locations visited) and postrecess inattention were assessed. No significant correlations were observed in either classroom. Lastly, separate repeated measures ANOVAs were calculated for differences between prerecess and postrecess inattention. A significant effect was observed for Classroom 1, $F(1, 19) = 3.66$, where inattention was higher before recess ($M = 6.65$) than after recess ($M = 5.40$). The effect for Classroom 2 was not significant; $F(1, 21) = 2.42, p < .06$, was in the hypothesized direction; prerecess inattention ($M = 6.39$) was higher than postrecess inattention ($M = 5.5$).

General Discussion

Three experiments were conducted to contextualize the school recess period in terms of the effects of recess timing on children's recess and classroom behaviors. The hypotheses generated by massed versus distributed practice and play deprivation theories were generally supported. Most basically, children, but especially boys, exhibited signs of inattention as length of deprivation increased. Results from all experiments implicated the gender-preference of the task in children's waning attention. This issue thus merits further study where different types of gender-preferred tasks are used. Data from these three experiments provide empirical support of anecdotal evidence from Taiwanese and Japanese schools and the massed versus distributed practice literature that, in order to maintain high levels of attention, childrens efforts should be distributed during the course of the day (Ebinghaus, 1885/1964 Stevenson & Lee, 1990; Stevenson, Stigler, Lucker, Lee, Hsu, & Kitamura, 1987; Toppino et al., 1991). In Japanese schools, primary school children typically have a 10–15-minute break every hour or so (Stevenson & Lee, 1990).

Theory also suggests a postdeprivation rebound at recess. Regarding the effects of play deprivation on children's social interaction and physical activity at recess, it seems that the venue for the recess period relates to the ways in which children rebound. On the outdoor playground, in relatively cold weather, rebound is expressed through social interaction, rather than physical activity. Interestingly, the oldest group of children observed in this study exhibited highest levels of both physical activity and social interaction. It may be the case that this group engaged in physically vigorous social games outdoors, like basketball, while young children may have spent their time in less socially cooperative activities (Pellegrini, 1990, 1995; Sutton-Smith, 1990). Future research might describe more closely the nature of these socially vigorous behaviors.

For both indoor recess experiments, rebound was expressed in terms of seeking out varied locations in classrooms; children sought out more varied classroom locations after long, compared to short, deprivation periods. In each case gender was implicated in this form of physically active exploratory behavior (Routh, Schroeder, & O'Tuama, 1974). It may be the case that the various physical locations contained stimulating, and relatively novel, activities. Children may have sought these activities as an expression of arousal, after a period of relative calm (Berlyne, 1966; Ellis, 1984; Fein, 1981). Issues of spatial density may also have been responsible for suppression of children's social interaction and more vigorous forms of physical activity indoors, compared to outdoors (Smith & Connolly, 1980).

The recess data from all experiments indicate that rebounding from deprivation may involve children sampling varied and interesting stimuli. During class work, they are exposed to specific work for sustained periods. When given the opportunity, at recess, they sample more varied environments. This phenomenon is supported by Bjorklund and Green's (1992) cognitive immaturity hypothesis. They posit that children's cognitive immaturity, relative to adults, is characterized by a short attention span and a desire to play after concentrated periods of attention. Such breaks from demanding cognitive tasks may facilitate school learning. It seems to be the case that children's attention to classroom tasks does wane as the duration of the class work increases. This may be a reason for Japanese and Taiwanese primary schools' including double the number of recess periods compared to American schools (Stevenson & Lee, 1990).

Children's behaviors at recess, however, did not relate significantly to their postrecess behavior. Future research should continue to examine this issue. It may be the case that the recess behavior relates to classroom behavior differently at various postrecess time intervals. For example, children may enter the classroom after recess in a highly excited state; this actually may interfere with attention to sedentary tasks immediately after recess. Similarly, after 40–50 minutes, recess effects may wane. Again, such waning attention may be the reason behind Japanese and Taiwanese recess policies.

The effects of deprivation on children's recess behavior are also relevant to researchers studying the relations between children's recess/playground

behavior and social competence (see Hart, 1993a, for a compilation; Pellegrini, 1995). For example, types of social and vigorous interaction on the playground are sometimes used to categorize children into peer status groups (e.g., Ladd & Price, 1993). The data from the present study show clearly that at least three contextual variables (recess timing, outdoor temperature, and indoor or outdoor venue) also affect children's social interaction and physical activity. Future research should examine more closely the way these, and other, mediator variables affect specific sorts of social and vigorous behavior.

Future research should also address the extent to which other theoretically relevant variables, such as temperature, affect levels of play behavior. In both experiments, temperature was significantly correlated with measures of outdoor play. This is consistent with the animal play literature (e.g., Burghardt, 1988; Fagen, 1981) and one study of preschoolers (Smith & Hagan, 1980). In tropical climates, low levels of physical activity are exhibited (Cullumbine, 1950). Future studies of spacious indoor play areas, with controlled temperatures, could address this problem directly.

Lastly, these experiments implicated gender-preference of classroom tasks in children's attention to those tasks. This finding has obvious importance for the design of subsequent studies and for school policy. Regarding the former, researchers must take care not to have task gender-preference confound designs. Regarding policy, educators should be aware of the fact that children's ability to attend to tasks is related to both child-level variables (such as temperament) and task-level variables, such as preference; this is clearly important as educators make inferences about certain learning disabilities (Pellegrini & Horvat, 1995).

In short, our research on children at recess attempted to contextualize the recess period within the school day. Different school policy variables, such as recess timing, as well as environmental variables, such as outdoor temperature, play an important role in the behavior that children exhibit on the playground. Given the reliability of the deprivation effects observed in the experiments reported here, it is time for schools to systematically study their recess policies. While it is common for schools, and politicians, to extol Asian educational practices, they should also consider Asian recess practices.

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