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Classroom benefits of recess

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Abstract Despite research demonstrating the importance of recess and free play for children, schools have been reducing free play time for more academic pursuits (Ramstetter et al. in J Sch Health 80:517–526, 2010; Waite-Stupiansky and Findlay in Educ Forum 66:16–25, 2001). Recently, there has been renewed interest in understanding the critical role that free play has for children's development. The current study was designed to contribute to this literature as well as investigate how the type of environment in which children play influences their behaviour in the classroom. Children in grades 3–5 were tested before and after recess on cognitive measures of sustained attention and creativity. We found an increase in children's sustained attention after recess. We additionally found that the type of environment in which children played differed depending on children's behaviour and traits. Our findings suggest that recess is an important factor in children's performance in school and should be considered an important part of the school day. Furthermore, we suggest that researchers should consider how individual differences influence the relationship between recess and children's performance in the classroom. Implications of this research for schools are considered.

Keywords Attention · Creativity · Free play · Playground environments · Recess

Introduction

When it comes to schooling and learning, the classroom is the prototypical environment that comes to mind; and with just cause. The classroom is the site of much learning in our modern educational system; and research has been conducted to better understand how the classroom can be structured and how the classroom environment can be designed to best

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meet the academic needs of children (Fraser and Fisher 1983; Sinclair and Fraser 2002; Spearman and Watt 2013). In addition to focusing on the classroom, it is important to consider other factors that influence learning in schools. One important factor which has started to receive more attention is recess.

Recess has traditionally been an important part of a typical school day for many children. However, recently, recess time has been limited or cut in many schools (Ramstetter et al. 2010; Waite-Stupiansky and Findlay 2001). Unfortunately, this reduction in recess is potentially harmful for children as recess is important for various reasons such as allowing children unstructured free play time and increasing physical activity, both of which have positive effects on the well-being and development of children (Kangas 2010; Milteer et al. 2012). While current research has begun to address the role of recess and physical activity in the development of children and for academic performance, more research is needed to understand the impacts of recess on children's performance in the classroom and therefore we hope to contribute to this important field of research.

As noted above, free play, like that which occurs during recess, is extremely beneficial for children. It is so important that, in 2012, the American Academy of Pediatrics published a clinical report outlining the importance of play for all aspects of children's development (Milteer et al. 2012). In terms of physical development, recess is important for maintaining healthy kids (Aggio et al. 2015; Janssen and LeBlanc 2010; Waite-Stupiansky and Findlay 2001). With obesity being a large concern for our population and children, in particular, recess is an excellent way to combat obesity (Aggio et al. 2015; Fairclough et al. 2012; Janssen and LeBlanc 2010). Additionally, physical activity stimulates muscle growth (Janssen and LeBlanc 2010), improves cardiovascular functioning (Janssen and LeBlanc 2010), and fights against symptoms associated with many diseases such as diabetes (Edmunds et al. 2010; Michaliszyn and Faulkner 2010; Miculis et al. 2015).

In addition to physical benefits, recess and free play offer many social and emotional benefits for children. Recess and unstructured play allow children to practise important skills such as communication, prosocial behaviour, sharing, problem solving, self-regulation and negotiation (Golinkoff et al. 2006; Ramstetter et al. 2010). Children also show improved imagination and creativity when given opportunities to engage in play (Mottweiler and Taylor 2014).

Beyond these domains, recess and free play have benefits for cognitive development and academic outcomes as well. The importance of giving breaks when working on tasks that require high cognitive loads has been known for a while (Pellegrini and Bjorklund 1997; Schutte et al. 2015). Recess allows children this break from the classroom environment. Additionally, teachers report better attention and fewer behaviour problems after recess (Barros et al. 2009; Jarrett et al. 1998; Pellegrini et al. 1995). These effects on attention and behaviour are particularly true for children with attention deficit hyperactivity disorder (ADHD, Jarrett et al. 1998), affecting as much as 10% of children in some districts (Wolraich et al. 2014).

Recess can be a learning environment on its own. Whether teaching skills such as the ones outlined above (e.g. Golinkoff et al. 2006; Ramstetter et al. 2010) or teaching children about specific principles related to the outdoors (Fisher-Maltese and Zimmerman 2015), the outdoors can be an important aspect of children's learning environment in schools. Instructors have even gone beyond topics related to the natural sciences and taught concepts such as mathematics using the outdoors (Pittman 2011).

Beyond the learning that can occur during recess, it is also valuable to consider how the type of environment or play equipment influences children's behaviour. Evidence suggests

that both the environment (i.e. how much vegetation or natural elements are present) and the available equipment can influence children's behaviour (Bagot et al. 2015; Brown and Burger 1984; Czalczynska-Podolska 2014; Hayward et al. 1974; Johnson and Hurley 2002; Malone and Tranter 2003). Children who play in environments with more natural elements generally experience greater restoration of attention (i.e. they are better able to focus on tasks after this exposure to natural elements) (Arbogast et al. 2009; Bagot et a. 2015). Research has shown that play environments can influence children's cognitive, social and emotional development (Brown and Burger 1984; Czalczynska-Podolska 2014). A distinction has been made between 'traditional' playgrounds and 'contemporary' playgrounds (Brown and Burger 1984; Hayward et al. 1974). Traditional playgrounds are characterised by a collection of single-purpose equipment (e.g. swings, slide) whereas contemporary playgrounds offer multi-purpose equipment, which is difficult to describe with names. These contemporary playgrounds offer children an opportunity to be creative with their play and create multiple ways to use them (Johnson and Hurley 2002; Moore 1989). While sometimes contrasting and conflicting results have emerged, evidence suggests that children prefer contemporary playgrounds to traditional ones, and also show more complex cognitive and social behaviour and increased creativity when using contemporary playgrounds over traditional playgrounds (Brown and Burger 1984; Susa and Benedict 1994). Another advantage of contemporary playgrounds is that they often offer opportunities for multiple types of play (group, solitary, cooperative, competitive, etc.) that can be beneficial for all children (Johnson and Hurley 2002).

With evidence accumulating on the positive effects of recess and play on children's development, many scientists have begun to advocate for schools to increase the time devoted to breaks from academic work (Golinkoff et al. 2006; Pellegrini and Bjorklund 1997). Professionals recommend that children engage in at least 60 min of physical activity per day (Edmunds et al. 2010; Erwin et al. 2012), and it seems reasonable for at least some of this to occur during the school day, allowing classroom teachers to reap the social and cognitive benefits described above. In the current study, we hope to advance our understanding of the role of recess on classroom performance by studying the effects of recess on sustained attention and creativity.

Methods

Participants

Participants included 99 children from elementary schools in two school districts. Children were in grades 3 ($n = 42$, 42.9% male), 4 ($n = 22$, 45.5% male) and 5 ($n = 35$, 31.4% male). Three participants were excluded because they were missing data (either before or after recess). Table 1 contains a breakdown of the grade levels and students' gender for each school for the participants included in the data analysis. We tested in one elementary school per district. While an additional 25 students were in attendance during measurement periods, they were assigned 'indoor' recess (because of misbehaviour, $n = 6$, or inclement weather, $n = 19$) and their data were excluded from the current study.

Materials

We collected the following measures before and after students left for recess.

Table 1 Demographic characteristics for Schools A and B

School	*n*	% of students			% Male
		Gr 3	Gr 4	Gr 5	
School A	37	56.8	0.0	43.2	27.0
School B	62	33.9	35.5	30.6	46.8

The 4th graders at School A had indoor recess on the day when we tested and were therefore excluded from our analyses

Sustained attention

To measure sustained attention, we asked students to read a short passage either about chipmunks or the White House, one before recess and the other after (the order was counterbalanced across classrooms). For these measures, students were instructed to cross out every letter 'e' that they came across as they read. They were told that, because there would be a question about the reading at the end, it was important to read carefully while also crossing out the letters. Students had as much time as needed to complete the passage. The passages were selected from teaching materials that were age appropriate and matched for the number of 'e's. (Each had a total of 48 'e's in the story.) Such letter-cancellation procedures are commonly used as assessments of attentional control in children and adults (Lezak 1995). We obtained a highly significant correlation between pretest and posttest scores in our sample, $r = 0.48$, $p < 0.001$, an indication of reliability even in the presence of anticipated changes in means.

Scoring

The score for this measure is the total number of 'e's that were correctly marked. We subtracted any errors (e.g. crossing off other letters) from the total to get the final score. Twelve subjects did not complete this measure at both assessments. For those ($n = 87$) who did, the average score on the White House version was 41.69 (SD = 4.33); for the chipmunk, the average score was 43.92 (SD = 3.43); this difference in scores was unexpectedly significant [$t(86) = 4.94$, $p < 0.001$].

Creativity

Our measure of creativity was the Alternate Uses Task (Plucker et al. 2011; Silvia et al. 2008). Students were given one of two everyday objects (either a spoon or a paperclip, with the order counterbalanced before and after recess, by classroom). Students were asked for what these objects were used and were provided with the correct response. They were then told about an alternate use each object (e.g. you could also use a spoon to scoop water out of a boat), and students were instructed to come up with as many other uses for these everyday objects. They were given 3 min to complete this task. The Alternate Uses Task has demonstrated good reliability and validity in prior studies (Runco 1991; Wallace and Russ 2015). Again, a highly significant correlation between pretest and posttest scores, $r = 0.63$, $p < 0.001$, provides an estimate of the reliability of this measure in our sample.

Scoring

The Alternate Uses Task (AUT) resulted in two measures of creativity. The first measure that we scored was *fluency*, which is the total number of responses that a child provided. We also created a measure of *non-redundant fluency*, which included the total number of 'unique' uses for each item. For example, a student who provided the responses 'to fling a bug', 'to fling a quarter', and 'to fling an arrow' as uses for a spoon would receive a fluency score of 3 (3 total uses) and a non-redundant fluency score of 1. (Because these answers reflect the same underlying use, this is one unique use for a spoon.) Two research assistants scored each participant's form. If there was any disagreement in coding, a third research assistant (or fourth, as needed) coded the responses until agreement between two research assistants was reached. While all of the data were eventually resolved, 86% of the forms were agreed upon with the first two coders. Seventy-four children provided code-able responses to both versions of the AUT. Children gave an average of 6.31 (SD = 3.25) alternate uses for a spoon, of which 5.80 (SD = 3.03) were non-redundant, and an average of 5.92 (SD = 3.48) alternate uses for a paperclip, of which 5.27 (SD = 3.20) were non-redundant; while the difference in fluent responses to the two versions did not approach significance [$t(73) = 1.15$], the difference in non-redundant fluency scores was marginally significant [$t(73) = 1.67$, $p < 0.10$].

Executive functioning

We also intended to assess executive functioning using the Trail Making Test (TMT), Versions A and B (Tombaugh 2004). In the TMT A task, students were asked to connect dots sequentially from 1 to 25. In the B version, the instructions were the same except that students were asked to connect dots with numbers and letters alternating between the two (e.g. 1–A–2–B etc.). Because of the recognised difficulty of the B version, this task was not counterbalanced across recess; rather, all students completed version A prior to recess and version B afterwards. Because scores are computed as the ratio of performance on B/A, there is no 'control' value for comparison; thus, our results on this measure were not interpretable and it was therefore excluded from our analyses.

Questionnaires

In addition to these measures, students completed after recess a questionnaire on which they indicated where they played during recess (e.g. swings, basketball court) by circling pictures of playground spaces included on the questionnaire. They were also asked to identify with whom they played at recess by listing names of fellow classmates and to indicate how much physical activity they engaged in during recess on a 5-point scale (ranging from 'none' to 'all' of their recess time).

Teachers also completed a questionnaire on which they reported the gender and rated the conscientiousness, creativity and extraversion of each student.

Environment of play

The formal playground areas at the two sites differed substantially in size. At the first school (School A), the play area—like the school—sat below the surrounding street in an area approximating one-tenth of an acre. The play area included one modern, multi-function structure, a swing set and a climbing wall. There were four benches beside the

playspace along the side of the sidewalk and school wall. There were several young trees along the perimeter of the play space. A few steps that run up the side of the adjacent hill led to a large grassy area (on the school property) approximating one-half an acre. The second school (School B) had a formal playspace that was level and covered nearly one-half an acre. It included three multi-functional structures, two different swing sets, additional equipment (e.g. a 'dinosaur') and some benches along the perimeter. There were many trees visible from the play area. In addition, the school had a separate black-topped play area closer to the school with five basketball hoops and a small amphitheater area.

Procedure

A principal investigator (CB) and several research assistants arrived at school about an hour prior to the start of students' lunch and recess break. After collecting consent and assent forms, students were asked to either work on an assignment from the teacher or to write about an adventure they had (if the teacher had no prepared assignment). The purpose of this task was to observe students while engaged in typical classroom activities. We had hoped to code attention behaviour during this time, but did not have enough personnel to qualitatively code behaviour. After working on this activity for 20 min, the researchers then obtained the measures of sustained attention, trail-making and creativity. During this time, teachers were asked to complete their survey for each student. Students were then dismissed for lunch and recess. After returning from recess, students completed the recess survey as well as the other versions of the sustained attention, trail-making and creativity task (again, administered in that order). Finally, students were again asked to spend 20 min on typical classroom activities. If the teacher did not provide work for the students, then the research team asked students to continue to write about their adventure or create a new adventure.

Results

To assess the effects of recess on sustained attention and creativity, we conducted ANOVAs comparing scores before and after recess (repeated measurements). Because preliminary analyses showed significant or nearly-significant differences in scores from different versions of the measures, all scores were standardised (z-transformed) by version prior to analysis. Order of completion of the two versions of each measure was included as a second factor in all analyses. Additional analyses added grade, school and gender as covariates; their interactions with time of assessment (pre-recess vs. post-recess) were also tested but, because of small Ns, higher-order interactions were not examined. Only significant effects of these additional variables are described.

To examine the possible role of play-spaces on these outcomes, we also conducted t-tests to compare the attention and creativity scores of children who played in common categories of spaces. Further tests were performed to explore selection processes (based on students' personalities or play preferences) that might account for obtained effects.

Sustained attention

The initial ANOVA revealed a marginally significant (0.21 SD) increase of sustained attention after recess ($M = 0.117$) as compared with before ($M = -0.097$) [$F(1,$

85) = 3.50, $p = 0.06$, $\eta_p^2 = 0.04$], and main effects for neither version-order [$F(1, 85) = 0.10$, *ns,* $\eta_p^2 = 0.00$] nor interaction between version-order and pre- vs. post-recess assessment time [$F(1, 85) = 0.39$, *ns,* $\eta_p^2 = 0.00$] were significant. When gender, grade and school were added into the analysis, the pre–post recess difference attained significance at the conventional level [$F(1, 81) = 4.94$, $p < 0.05$, $\eta_p^2 = 0.06$]; no other effects approached significance.

Creativity

To assess the effects of recess on children's creativity, ANOVAs were conducted on overall fluency and non-redundant fluency in responses to the Alternate Uses Task.

Although there was a small (0.06 SD) increase in overall fluency post-recess ($M = 0.027$) compared with than pre-recess ($M = -0.035$), this difference did not approach significance [$F(1, 72) = 0.37$, *ns,* $\eta_p^2 = 0.00$]; there was a main effect neither for version-order [$F(1, 72) = 2.05$, *ns,* $\eta_p^2 = 0.03$] nor interaction between version-order and pre- versus post-recess time of assessment [$F(1, 72) = 0.00$, *ns,* $\eta_p^2 = 0.00$]. Adding school, gender and grade made no difference in these effects, although there was a marginally significant tendency for girls ($M = 0.099$) to have higher fluency scores than boys ($M = -0.29$) [$F(1, 68) = 3.15$, $p < 0.10$, $\eta_p^2 = 0.04$].

There was a similarly small (0.08 SD) increase in non-redundant fluency scores after recess ($M = 0.033$) compared with before ($M = -0.044$) that also failed to reach significance [$F(1, 72) = 0.58$, *ns,* $\eta_p^2 = 0.01$]. There was a marginally significant order effect [$F(1, 72) = 2.99$, $p < 0.10$, $\eta_p^2 = 0.04$] reflecting the fact that those who received the 'spoon' version first gave more non-redundant answers ($M = 0.174$) overall than those who received the 'paper clip' version first ($M = -0.184$). There was no interaction between version-order and pre-post recess time of assessment [$F(1, 72) = 0.00$, *ns,* $\eta_p^2 = 0.00$]. The addition of grade, school and gender had no effect on these results. However, girls had significantly higher non-redundant fluency scores ($M = 0.129$) than boys ($M = -0.342$) [$F(1, 68) = 4.63$, $p < 0.05$, $\eta_p^2 = 0.06$].

Relations to play

We conducted a series of analyses to see whether what kids did at recess might provide insight into the beneficial effects of recess. Based on featural similarities, four categories of play places were identified: (1) basketball hoops, open blacktop (present at only one school) and sidewalk, (2) nature (grassy areas or near trees and bushes), (3) playground equipment and (4) playground seating (benches). Whereas children frequently reported playing in more than one of these locations, analyses were conducted for each category individually; children who played in each place category were compared with children who did not on changes in sustained attention and creativity. Significant findings were further explored to ascertain whether differences might be accounted for by children's personalities (extraversion, conscientiousness or creativity) as rated by their teachers or characteristics of their play (e.g. number of peers played with or activity-level) as reported by the children. Six children failed to indicate where they played and were excluded from these analyses.

Basketball/open blacktop/sidewalk Sixty children reported playing basketball or on the open blacktop (one school) or sidewalk. These children showed smaller increases in sustained attention after recess relative to children who didn't play in these spaces [SAT

change: $M = 0.015$ vs. $M = 0.533$; $t(79) = 2.16$, $p < 0.05$, $d = 0.49$]. They also showed reduced fluency scores pre- to post-recess compared with their peers who didn't play in these spaces (whose fluency increased from pre-recess to post-recess) [Fluency change: $M = -0.113$ vs. $M = 0.313$; $t(66) = 2.03$, $p < 0.05$, $d = 0.51$]; however, because children playing in these spaces had higher fluency scores prior to recess [Fluency pre-recess: $M = 0.19$ vs. $M = -0.39$; $t(66) = -2.45$, $d = 0.62$], they ended up nearly equal to their peers in their post-recess scores.

Boys (78%) were more likely to play in these areas than girls (55%) [χ^2 (1, $N = 93$) = 5.16, $\Phi = 0.24$]. Children playing in these spaces also reported playing with more peers [$M = 4.63$ vs. 3.48; $t(91) = -2.06$, $d = 0.45$] and were rated as more extraverted ($M = 3.42$ vs. 2.76) by their teachers [$t(90) = -3.33$, $p < 0.01$, $d = 0.72$].

Nature Just under one-half of children ($n = 44$) reported playing in/around natural features on these playgrounds. Children who reported playing in these areas showed no differences in sustained attention or fluency/non-redundant fluency scores pre- to post-recess. In fact, the only significant difference was that they reported playing in more categories of places ($M = 2.00$ vs. 1.16) than their peers [$t(91) = -8.45$, $p < 0.001$, $d = 1.76$].

Playground equipment About one quarter of children ($n = 28$) reported playing on specific pieces of playground equipment. These children showed greater increases in sustained attention pre- to post-recess than children who didn't play on the equipment [SAT change: $M = 0.537$ vs. $M = 0.052$; $t(79) = -1.96$, $p = 0.05$, $d = 0.46$]. They also experienced greater increases in creativity pre- to post-recess while their peers experienced slight decreases [Fluency-change: $M = 0.407$ vs. $M = -0.132$; $t(66) = -2.55$, $p < 0.05$, $d = 0.65$; Non-redundant fluency-change: $M = 0.360$ vs. $M = -0.083$; $t(66) = -2.07$, $p < 0.05$, $d = 0.53$], but it is noteworthy that their creativity scores started out lower [pre-Fluency: $M = -0.39$ vs. $M = 0.15$; $t(66) = 2.23$, $p < 0.05$, $d = 0.57$; pre-Non-redundant Fluency: $M = -0.37$ vs. $M = 0.11$; $t(66) = 2.06$, $p < 0.05$, $d = 0.53$].

Girls (41%) were more likely than boys (14%) to report playing on the equipment [χ^2 (1, $N = 93$) = 8.04, $p < 0.01$, $\Phi = 0.29$]. Children playing on the playground equipment also reported playing in more categories of places than their peers [$M = 2.04$ vs. $M = 1.35$; $t(91) = -5.46$, $p < 0.0\ 01$, $d = 1.25$].

Benches A small minority of children reported playing on the benches adjacent to the playgrounds ($n = 13$). These children showed a greater increase in sustained attention relative to their peers, although the difference was only marginally significant [SAT change: $M = 0.732$ vs. $M = 0.114$; $t(79) = -1.94$, $p = 0.06$, $d = 0.59$] and their attention pre-recess also tended to be lower than that of their peers [pre-recess SAT: $M = -0.63$ vs. $M = -0.05$; $t(79) = 1.72$, $p < 0.10$, $d = 0.56$]. No differences in creativity scores obtained or approached significance.

Children playing on the benches were almost exclusively girls (only one boy listed this as a locus of his play) [χ^2 (1, $N = 93$) = 6.50, $p < 0.05$, $\Phi = 0.26$]. Children who played on the benches also reported playing with fewer peers [$M = 2.31$ vs. $M = 4.54$; $t(91) = 2.96$, $p < 0.05$, $d = 0.89$] and were rated as less extraverted by their teachers [$M = 2.69$ vs. $M = 3.27$; $t(90) = 2.01$, $p < 0.05$, $d = 0.61$]. They also reported moving around less during recess ($M = 3.92$ vs. 4.44), though this result was only marginally significant [$t(91) = 1.83$, $p < 0.10$, $d = 0.50$; and they reported playing in more categories of places than their peers [$M = 2.00$ vs. $M = 1.48$; $t(91) = -2.80$, $p < 0.05$, $d = 0.85$].

Discussion

The purpose of this study was to evaluate the effects of recess on children's cognitive skills and academic performance in the classroom. While our measures of creativity did not show significant changes, we did find significant increases in sustained attention after recess as opposed to before. This finding is in line with previous studies that have revealed beneficial effects of recess on attention (Barros et al. 2009; Holmes et al. 2006; Jarrett et al. 1998; Pellegrini et al. 1995). However, these previous studies focused on global measures of attention (i.e. whether kids were 'on task' and focused on classroom activities). In contrast, the current study used a very specific measure to assess sustained attention (also called vigilance), which involves being able to identify specific stimuli (in this study, the letter 'e') found at randomly-occurring intervals (Erickson et al. 2015; Helton and Russell 2015; Sarter et al. 2001). This requires individuals to stay focused on a task while inhibiting other distractors. Sustained attention is an important basic cognitive ability that can help to support higher-order cognitive abilities, such as language (Bush et al. 2015; Jongman et al. 2015) and memory (Bush et al. 2015; Helton and Russell 2015; Janculjak et al. 2002). Not only can sustained attention support these important higher-order functions, but sustained attention can support learning as well (Erickson et al. 2015). Therefore, improvements in sustained attention can lead to improvements in other cognitive skills. Our findings suggest that allowing children to have breaks through recess could be one key way to improve children's cognitive skills from the bottom up.

Another interesting finding from this study is the effect that different play areas had on children's performance in the classroom. We found that children who played in the basketball hoops/blacktop area/sidewalk showed lower increases in sustained attention pre- to post-recess. While this might reflect the nature of the activities (often basketball or other multi-player games) that could have taxed attentional resources, we are cautious about drawing this conclusion or the parallel conclusion that playing on playground equipment was responsible for increases in sustained attention. In fact, overall, we did not find many pre to post changes in sustained attention or creativity that could be specifically tied to the activities or places of recess play. When such differences were obtained, further analyses suggested that they often originated pre-recess and could thus reflect children's self-selection in a 'free play' environment. For example, children who played on the blacktop area had higher fluency scores on the creativity task prior to recess, and children who played on the playground equipment had lower creativity scores (both fluency and non-redundant fluency) prior to recess. In both cases, the differences seemed to disappear after recess. Prior literature has mostly focused on how time spent during recess can affect children's behaviour. Studies have reported that different types of play environments can influence children's subsequent behaviour. For instance, research has revealed that contemporary playgrounds stimulate creativity more than traditional playgrounds (Brown and Burger 1984; Susa and Benedict 1994). While we do not discount all studies showing this result, our findings suggest that the causal link sometimes can be reversed, because children select options according to their personalities and current states. Perhaps children who are more creative are drawn more towards opportunities for more creative and free play. Likewise, the children in our study who played on the benches tended to play with fewer peers and be rated by their teachers as less extraverted. Just as some kids need a chance to be social, run around and interact with their peers, recess can be equally as valuable for introverted children because it gives them a break from social interaction in the classroom and 'quiet time' to recharge (Arbogast et al. 2009). It should be obvious that children's

personalities, abilities and skills, as well as the environment, are interacting to affect children's play choices and behaviour and performance in the classroom after recess. However, our results highlight the importance of considering what elements children bring to this situation and the need to take these individual variables into account when studying the relationship between recess and children's performance in the classroom. Notably, in this study, children's play choices seemed to bring them 'in line' with their peers (in terms of sustained attention and creativity after recess); perhaps the most important attribute of recess is that it is 'free-play", giving children the opportunity to self-direct their activities. Perhaps freedom allowed for the overall increase in sustained attention recorded here.

Given a growing body of research that highlights the importance of access to nature as a means of recovering directed attentional abilities (Berman et al. 2008), some readers could be surprised that we found no relationship between play in nature spaces and improvement in sustained attention or creativity. However, we note that, in this study, the amount of 'nature' on the playgrounds was relatively limited, mostly grassy areas and a few small trees, and it is unclear that the 'naturalness' of these features was central to the children's activities versus serving as convenient resource for something else (e.g. being the 'safe' space in a game of tag); nature used in this way would not be anticipated automatically to facilitate restoration (Kaplan 1995).

One limitation of the current study was the timing of recess and lunch. In the schools in which we tested, children got a break from the classroom for lunch and then recess immediately following. Because we attempted to be as noninvasive to the typical school day, we did our testing before students left for their combined lunch and recess break and then immediately afterwards. Thus, lunch is confounded with recess. It is clearly possible that the effects that we found were a result of the food intake and not the opportunity for physical activity. Hopefully future research can tease apart these two influences and replicate our findings for recess alone. Another limitation of the current study involves the measures that we chose to use. Unfortunately, our measure of executive functioning could not be scored to assess changes across recess. While we were able to assess changes across recess in creativity using an objective coding routine, some have argued that creativity is by its nature very abstract and subjective (Silvia et al. 2008) and urge the use of more subjective ratings to capture creative performances; perhaps such an approach would have yielded differences whereas ours did not. Finally, we would also recommend using individualised collection of data which would not only yield cleaner data (because one can assure that each student understands instructions and can minimise the presence of distracters), it could also yield additional measures (e.g. individual response times) that are virtually impossible to get in a classroom testing situation (e.g. Kelz et al. 2015).

We would also encourage future researchers to use a greater number of measures of the key constructs. While we selected singular measures of our variables in order to minimise our intrusion on classroom instructional time, we are unable to demonstrate that our findings are not unique to the measures selected. Perhaps recess has effects on other facets of creativity that are not captured with the alternate uses task and, as noted above, there are other aspects of attention (beyond vigilance) that impact classroom behaviour and students' ability to learn. Understanding the various ways in which recess can positively affect these behaviours is important for making the case for recess to administrators who are looking for ways to increase instructional time to meet pressure to improve standardised test scores.

Based on the findings from this study, we suggest that recess be offered for all children. These findings contribute to the existing literature that demonstrates how valuable recess can be for children's development and their behaviour and performance in school. More

importantly, the current study demonstrates that recess can improve sustained attention, which is a critical and fundamental cognitive skill that can support children's learning in multiple domains. By giving children a break from classroom activities, they might be better prepared to learn and develop skills later in the day. Based on years of cognitive research, we anticipate that multiple breaks would have an even greater effect on children's behaviour and performance in school and hope to see more research on this topic. Another implication of this study is the importance of providing a diverse set of equipment and environments in which children can play and explore during recess. Contemporary playgrounds, which contain varied equipment and materials, can provide many opportunities for all types of children to engage in play that best suits them (Johnson and Hurley 2002). Our data further support this idea because we found differences across children based on the type or equipment with which they chose to interact. Because recess can serve different purposes for different children (e.g. extroverted vs. introverted children), it becomes important to provide variety in order to best meet the needs of all children. Recess is such a valuable experience for children that it needs to be an important part of every school day.

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