

VIEWS OF NATURE AND SELF-DISCIPLINE: EVIDENCE FROM INNER CITY CHILDREN

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Abstract

Children growing up in the inner city are at risk of academic underachievement, juvenile delinquency, teenage pregnancy, and other important negative outcomes. Avoiding these outcomes requires self-discipline. Self-discipline, in turn, may draw on directed attention, a limited resource that can be renewed through contact with nature. This study examined the relationship between near-home nature and three forms of self-discipline in 169 inner city girls and boys randomly assigned to 12 architecturally identical high-rise buildings with varying levels of nearby nature. Parent ratings of the naturalness of the view from home were used to predict children's performance on tests of concentration, impulse inhibition, and delay of gratification. Regressions indicated that, on average, the more natural a girl's view from home, the better her performance at each of these forms of self-discipline. For girls, view accounted for 20% of the variance in scores on the combined self-discipline index. For boys, who typically spend less time playing in and around their homes, view from home showed no relationship to performance on any measure. These findings suggest that, for girls, green space immediately outside the home can help them lead more effective, self-disciplined lives. For boys, perhaps more distant green spaces are equally important.

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Introduction

Children growing up in the inner city are at risk of academic underachievement (Brooks-Gunn, 1986), juvenile delinquency (Berrueta-Clement, 1984), teenage pregnancy (Furstenberg, 1976), and other important negative outcomes, with profound consequences for themselves, those around them, and society. Outcomes such as these often reflect failures of self-regulation, or self-discipline (Baumeister *et al.*, 1994). Could a feature of the physical environment affect inner city children's capacity for self-discipline, and as a consequence, play a role in these outcomes?

This paper explores whether children's self-discipline might be enhanced by contact with nature. Previous research suggests that natural settings and views can help renew the psychological resource used in deliberately directing attention. It has been proposed that self-discipline draws on this same resource (Kuo, 2000); if so, we would expect self-discipline to decline when this resource is depleted or fatigued, and we would expect self-disci-

pline to improve when this resource is renewed. Thus, regular contact with natural settings and views might be expected to enhance children's capacity for self-discipline on a day-to-day basis.

To test this possibility, this study tested for links between the view from home and three forms of self-discipline in children. Specifically, it examined whether, in an inner city neighborhood, children with 'greener' views from home were better able to concentrate, inhibit initial impulses, and delay gratification.

Three forms of self-discipline

Concentrating, inhibiting initial impulses, and delaying gratification are each distinct and important forms of self-discipline. They are distinct forms of self-discipline in that each involves overriding different, unhelpful tendencies. And they are important in that each seems likely to play a pivotal role in the course of a young person's life. More specifically, each seems likely to play an important role in negotiating the risks faced by inner city children:

academic underachievement, juvenile delinquency, and teenage pregnancy.

Concentrating requires overcoming the tendency for the mind to wander, and sustaining attentional focus despite distractions, boredom, frustration, or fatigue. As it involves directing one's thoughts to the topic at hand, concentration is the form of self-discipline that most clearly draws on our capacity to deliberately direct attention. The ability to concentrate is important because it enables an individual to mentally 'buckle down' and stay on a task long enough to make progress and be effective. It also seems to enable an individual to complete tasks more quickly. In children, chronic or acute deficits in concentration could result in valuable time spent in less-than-effective ways. A child too mentally fatigued to concentrate might spend countless hours in front of books and assignments, yet learn very little due to their inability to focus on the task at hand. Indeed, inattentiveness is a significant predictor of academic underachievement (e.g. Mantzicopoulos, 1995; Rowe, 1992).

Inhibiting initial impulses¹ requires overcoming the tendency to jump to conclusions or to act on impulse. It involves overriding one's initial response to a problem or situation, in order to consider alternatives or consider the potential costs and benefits of a course of action. The ability to inhibit initial impulses is important because it gives rise to more prudent and cautious choices, and consequently, more prudent and cautious actions. Chronic or acute deficits in a child's ability to inhibit impulses can have serious, negative long-term repercussions. For example, a child too mentally fatigued to inhibit impulses is more likely to give in to repeated offers of a lit cigarette or other dangerous substance. A diminished capacity to inhibit impulses could also cause a child to accept a dare to jump from one balcony to the next, or to snatch an elderly woman's purse. Consistent with this, impulsivity is consistently linked with risky behavior (Donohew *et al.*, 2000; McCoul, 2000), aggression and violence (e.g. Hynan & Grush, 1986; Markovitz, 1995), and delinquency (Lynam, 2000; Rigby, 1989; White, 1994).

Delaying gratification requires overcoming impatience and the tendency to favor short-term rewards over long-term goals. It involves internalized standards and morals. The ability to delay gratification is important because reaching future goals often requires postponing immediate rewards. It assists the individual in persisting at goal-oriented behaviors for the good of their future. Even a temporary deficit in the ability to delay gratification can have ma-

nor repercussions. For example, a temporary inability to delay gratification might lead a young couple to give in to immediate desires and engage in unprotected sex, rather than wait until they are better prepared. Consistent with this, poor ability to delay gratification is a significant predictor of unplanned pregnancy (Donoghue, 1993; Shaffer *et al.*, 1978).

In sum, concentration, impulse inhibition, and delay of gratification may play pivotal roles in the course of a young person's life. How might these vital forms of self-discipline be enhanced by the presence of natural elements immediately outside the home? We suggest that each of these forms of self-discipline draws on a resource which can be renewed by contact with nature — the capacity for deliberate or self-directed attention. In the next section, we review the literature on how natural settings and views can renew directed attention; we then consider why self-discipline might draw on this resource.

How natural settings and views restore directed attention

Both theory and evidence suggest that the resource underlying our capacity to direct attention can be renewed by contact with nature. Attention Restoration Theory (Kaplan, 1995; Kaplan & Kaplan, 1989) builds on William James' description of attention to provide an explanation for why natural settings and views might be expected to renew this resource. James observed that certain elements in the environment are effortlessly engaging, and draw on what he called involuntary attention: 'strange things, moving things, wild animals, bright things...' (James, 1962, p. 231). For those stimuli and situations that do not effortlessly engage us, he proposed, we draw on a voluntary form of attention, or what S. Kaplan (1995) calls directed attention.

The mechanism underlying directed attention appears to behave like a mental muscle. With prolonged or intense use, the capacity to deliberately direct attention becomes fatigued and performance declines (Cohen & Spacapan, 1978; Glosser & Goodglass, 1990). In *Attention Restoration Theory*, S. Kaplan proposed that stimuli that draw primarily on involuntary attention give directed attention a chance to rest. Further, he noted that natural settings and views appear to draw on involuntary attention; as a consequence, contact with nature should assist in recovery from the fatigue of directed attention.

Evidence in Adults. A number of studies in adult populations support Attention Restoration Theory. Several studies have shown that nature draws upon involuntary attention (e.g. Kaplan, 1973, 1983; Kaplan & Talbot, 1983, Ulrich, 1981). In addition, a number of other studies have shown that exposure to natural environments can be effective in restoring directed attention from fatigue (Canin, 1991, Cimprich, 1990, Hartig *et al.*, 1991; R. Kaplan, 2001; Kuo, 2001; Lohr *et al.*, 1996; Miles *et al.*, 1998; Ovitt, 1996, Tennessen & Cimprich, 1995).

Of the previous empirical studies linking nature and directed attention, three are particularly relevant to the study presented here. These studies focus on residential nature and residential views of nature. In one study, residents randomly assigned to relatively 'green' high-rise apartment buildings scored significantly higher on an objective measure of attention than did residents assigned to relatively 'barren' buildings (Kuo, 2001). In another study, university students with 'all natural' or 'mostly natural' views from their dormitory room windows scored significantly higher on two objective measures of directed attention than did residents with 'mostly built' or 'all built' views (Tennessen & Cimprich, 1995). And in a third study, residents of low-rise apartment buildings with window views of natural elements or settings rated themselves as functioning better on several indices thought to be related to attention restoration (Kaplan, 2001). Thus, there is some reason to think that residential views of nature might prove restorative in this study.

Evidence in children. Numerous studies have linked directed attention to nature and near-home nature in adults; very little research has been conducted with children. Although Attention Restoration Theory does not exclude children and it has been suggested nature might support directed attention in children (Trancik & Evans, 1995), only two empirical studies have examined this possibility. Wells (2000) examined children who moved from poor quality housing to better quality housing in better neighborhoods. Among these children, those whose move involved the greatest increase in nature had the highest rated levels of attentional functioning post-move. Another study provides three additional pieces of evidence about the link between nature and directed attention in children. That study revealed that exposure to nature through green activity settings was related to better attentional functioning (reduced attention deficit symptoms) in a population of children with Attention

Deficit Disorder (Faber Taylor *et al.*, 2001). In that study, parents rated a variety of leisure activities with respect to whether those activities left their child's attention deficit symptoms better than usual, worse than usual, or the same as usual: results indicated that children function better than usual after activities in green settings. Moreover, ratings were higher for those activities conducted in green settings than for those conducted in built outdoor or indoor settings. In addition, the greener a child's usual play setting, the less severe their attention deficit symptoms were rated in general. And most relevant to the current study, several measures of residential greenness were significantly and negatively linked to overall severity of symptoms — but only for girls and not for boys. Multiple potential confounds were evaluated; none could explain the relationships between green settings and better attentional functioning.

In sum, not only do theory and evidence suggest that nature supports directed attention in adults, but there is some evidence that it does so in children as well. Moreover, there is evidence to suggest that near-home nature and residential views of nature can help renew directed attention.

Does self-discipline draw on directed attention?

Might self-discipline draw on directed attention, and hence, be renewed by contact with nature? More than one investigator has proposed that the capacity for self-discipline is a limited but renewable resource (Kuo, 2000; Muraven & Baumeister, 2000). Perhaps it is no coincidence that both what personality psychologists call 'self-control strength' (Muraven & Baumeister, 2000) and what environmental psychologists call 'directed attention' (Kaplan, 1995) are subject to the same patterns of decline and restoration — decline with overuse and renewal with rest. Kuo (2000) has proposed that the mental mechanism that underlies self-discipline and the mental mechanism that underlies directed attention are one and the same.

Although directed attention has been operationalized primarily in terms of effective cognitive performance (e.g. maintaining focus or paying attention, resisting distractions, planning, decision making, remembering things), it is clear from Kaplan's description that the mechanism he proposes may be involved in much more (Kaplan & Kaplan, 1989; Kaplan, 1995). In essence, Kaplan proposes a general control mechanism for directing any of a variety of different forms of mental activity, including thoughts, images, sensations, and

impulses. Thus, the mechanism for directing attention may be involved in the inhibition of any strong-but-unhelpful mental activity in favor of any weak-but-helpful mental activity.

Each of the three forms of self-discipline examined here could plausibly draw on this proposed mechanism. Concentration involves both inhibiting distractions and other task-irrelevant thoughts, and supporting on-task thoughts. Similarly, inhibition of impulses may involve inhibiting initial impulses, blocking out the stimuli that give rise to those impulses, and supporting the consideration of alternatives. And delay of gratification may involve inhibiting impulses, inhibiting unhelpful thoughts and sensations that fan one's desire for immediate gratification (e.g. warm chocolate cake), and supporting thoughts about long term goals (e.g. weight loss).

Consistent with this conception, a number of studies and reviews have linked voluntary or controlled aspects of attention to forms of self-discipline and self-regulation. Mischel and colleagues have shown that children's ability to direct attention away from immediate rewards is pivotal in their ability to delay gratification (Mischel *et al.*, 1972), and that adolescents' attentiveness and ability to concentrate is predicted by their ability to delay gratification as pre-schoolers (Shoda *et al.*, 1990). Two studies have independently linked aspects of attention to more disciplined ways of dealing with anger or conflict (Eisenberg *et al.*, 1994; Kuo & Sullivan, 2001b). In factor analyses of questionnaire data, Rothbart *et al.* (2001) have found a broad effortful control factor, in which attentional focusing clusters with inhibitory control. Posner & Rothbart (2000) review literature suggesting that high-level attentional networks provide the neural basis for self-regulation. And finally, in their review of over 500 books and articles on self-regulation failure, Baumeister *et al.* (1994) conclude that loss of control over attention is a key factor in self-regulation failure.

This study

If nature renews directed attention in children, and if directed attention is indeed involved in self-discipline, as we suggest, then children's self-discipline should be strengthened by contact with nature. This study examined whether near-home nature is related to three forms of self-discipline in both girls and boys. Specifically, we asked

- *Do residential views of nature enhance children's concentration?*

- *Do residential views of nature enhance children's inhibition of initial impulses?* and
- *Do residential views of nature enhance children's delay of gratification?*

This study breaks new ground in two respects. First, previous research has linked concentration to nature empirically, but only in adults with normal attentional functioning and in children with compromised attentional functioning. This study is the first to examine the relationship between nature and concentration in a sample of children with normal attentional functioning. And second, although nature and concentration have been linked in some populations, neither impulse inhibition nor delay of gratification have been linked to nature in any population. The findings of two studies (Kuo & Sullivan, 2001b; Kuo, 2001) are consistent with a link between nature and self-discipline, but neither of these studies directly examined impulse inhibition or delay of gratification.

To examine the relationship between residential views of nature and concentration, impulse inhibition, and delay of gratification in children, we conducted one-on-one tests and interviews with a sample of inner city girls and boys and their mothers. Objective performance measures were used to assess children's concentration, inhibition of initial impulses, and delay of gratification. Mothers' ratings were used to assess the naturalness of views from home.

Methods

Site and design

The site was Robert Taylor Homes, a large public housing development in Chicago, Illinois, USA. At the time of this study, Robert Taylor Homes (RTH) comprised 28 16-story buildings. It had over 12,000 official residents, of whom 31% were children between 5 and 14 years old (CHA, 1995). Almost all of the heads of household (99.7%) were African-American and most (75%) received Aid to Families with Dependent Children (CHA, 1995).

The physical characteristics of RTH help make it an optimal site for studying the effects of near-home nature. When the development was built in the 1960s, trees and grass were planted in the common spaces next to every building. Over the years, for reasons of reducing maintenance and dust, grass in most of the spaces was replaced with pavement, causing many of the trees to die and subsequently be removed. This attrition has left some buildings

barren and others with pockets of green. While the amount of nearby nature varies from building to building, the buildings themselves are nearly identical in architecture, layout, size, and number of residential units. Thus, many would-be confounds are held constant at RTH, allowing for clean comparisons of the effects of near-home nature.

The social characteristics of RTH also help make it an optimal site for studying the effects of near-home nature. The housing assignment practices of Chicago Housing Authority result in *de facto* random assignment of residents to buildings, and residents are not involved in landscaping decisions or maintenance. Previous research at this site with a different sample of residents found no systematic relationships between levels of vegetation outside apartment buildings and residents' age, education, marital status, work status, income, Aid to Families with Dependent Children status, number of children at home, length of residence, or numerous other factors (Kuo & Sullivan, 2001a).

Participants and procedures

To boost rapport between the participants and interviewers, we hired and trained residents of RTH as interviewers. The four interviewers were African-American women between 30 and 45 years old. Each had achieved at least a high school diploma. The interviewers received 40 hours of training in interviewing and administering objective performance measures from our staff and the National Opinion Research Center.

In order to minimize distractions to interview participants during the interview, we also hired and trained residents to serve as child-care providers. Child care providers accompanied the interviewers to the interviews and kept any children in the apartment who were not being interviewed safe and entertained. All child care providers were at least 18 years old and were completing or had completed high school.

Twelve apartment buildings with varying amounts of vegetation were sampled; we excluded buildings adjacent to parks, police stations or other relatively unique features. Within the selected buildings, sampling was limited to the 2nd, 3rd, and 4th floors because those floors provide residents maximal views of the trees and grass outside their building; there are no residences on the ground floor.

To recruit participants, flyers were posted and interviewers canvassed door-to-door. Interviewers did not canvas or interview in the building in which they lived, and they were instructed not to inter-

view anyone with whom they were acquainted. Parent-child pairs were invited to participate in a University of Illinois study about 'the physical environment of the neighborhood and how it affects mothers and children.' Any 7–12 year old child and their mother or primary caregiver was eligible to participate, so long as they had been residents of RTH for at least a year. Potential participants were told that they could refuse to answer any question, and could stop the interview at any time. Adults received \$10 and children received a small gift at the completion of the interview.

Of the eligible adult-child pairs approached, 169 of 174 agreed to participate — a 97% response rate. Ninety one of the child participants were boys; 78 were girls. Both the boys' and girls' mean ages were 9.6 years old (ranges 7.7–11.7 and 7.7 to 12.2 years old, respectively). All participants were African-American.

Interviews and testing were conducted in participants' apartments at the kitchen table. Adult interviews and testing typically lasted a little more than an hour. Child interviews and testing typically lasted 45 minutes.

Measures

We measured near-home nature and three types of self-discipline: concentration, inhibition of initial impulses, and delay of gratification.

Near-home nature. Near-home nature was assessed by asking the adult participants to rate the views from their apartment windows. Ratings in response to two items were combined: 'How much of the view from your window is of nature (trees, plants, water)?' and 'How much of your view from your window is man-made (buildings, street, pavement)?' (reverse-scored). Each item was rated on a five-point scale, from 0 'not at all' to 4 'very much.' Figure 1 shows barren and green areas immediately outside RTH apartment buildings.

Concentration. Concentration was assessed using four tasks. These tasks have previously been used as measures of attention or concentration: Symbol Digit Modalities Test (Cimprich, 1992, Lezak, 1983; Smith, 1968), Digit Span Backwards (Cimprich 1992; Wechsler, 1955), Alphabet Backwards (Cimprich, 1992), and Necker Cube Pattern Control (Cimprich, 1990; Schwartz, 1994; Tennessen & Cimprich, 1995). Phenomenologically, each of these tasks is characterized by the effortful use of attention or paying attention.



FIGURE 1. Views of near-home nature vary from apartment to apartment at Robert Taylor Homes.

In Symbol Digit Modalities (SDM), the participant substitutes numbers for nine geometric symbols, including three mirror image pairs, as quickly as possible (Smith, 1973). Scores on SDM were the number of correct substitutions in a 90-s period. One participant's score was more than 2 S.D. higher than the next highest score; this outlier was excluded from further analysis.

In Digit Span Backwards (DSB), the participant listens to a sequence of numbers two to eight digits long and then repeats the sequence aloud in reverse order (Wechsler, 1955). Scores on DSB were the longest number of digits repeated correctly before two consecutive failed trials.

In Alphabet Backwards (ABK), the participant recites the alphabet backwards beginning with a specified letter (e.g. the letter u) (Cimprich, 1992). In this study, three trials were given; scores were the average number of letters recited in correct (reverse) sequence divided by the average time spent reciting them (i.e. the average speed with which the participant could recite the alphabet backwards).

In Necker Cube Pattern Control (NCPC), the participant attempts to mentally 'hold on to' one interpretation of an ambiguous stimulus (Tennessen & Cimprich, 1995). First, the participant stares at a three-dimensional line drawing of a cube for 30 s, signaling each time the front and back faces appears to reverse. Then, the participant tries to mentally 'hold the cube still' or inhibit it from reversing for 30 s, signaling each time the faces reverse. Scoring for this measure was the percent reduction in the number of reversals from the first task — letting the cube reverse freely — to the second task — holding the cube still. Scores were based on performance of the two tasks after a practice trial.

Scores on SDM, DSB, ABK, and NCPC were standardized and averaged to create a summary index of

concentration. Z-scores were used because the four tasks were scored on very different scales.

Inhibition of initial impulses. Inhibition of initial impulses was assessed by combining scores on three established measures of impulsivity or impulse inhibition: Matching Familiar Figures Test (e.g. Welsh *et al.*, 1991; Brown & Quay, 1977; Kagan, 1966), Stroop Color-Word Test (Boucugnani & Jones, 1989; Davies *et al.*, 1984; Dyer, 1973), and Category Matching (Melnyk & Das, 1992). Each of these tasks tends to evoke an initial response that is incorrect or very likely to be incorrect. In each of these tasks, good performance requires avoiding the initial incorrect response in order to discern the correct response.

In Matching Familiar Figures (MFF), the participant is presented with a target figure and a set of six alternatives; the task is to select the single alternative that exactly matches the target figure (Kagan, 1966). Because all the alternatives all look the same at first glance, participants must be careful in evaluating them. For each trial, the number of erroneous choices a participant makes before selecting the correct alternative is recorded. In this study, a participant's score on the measure was the total number of errors over 12 trials. MFF has been found to be a reliable measure: reliability for total number of errors ranges from 0.62 (Block *et al.*, 1974) to 0.78 (Cairns & Cammock, 1978). Matching Familiar Figures has also been found to be a valid measure of impulsivity (Brown & Quay, 1977; although *cf.* Block *et al.*, 1974).

In the Stroop Color-Word Test (Stroop), the participant is given a sheet of paper with 50 color names presented in rows (Dodrill, 1978). Each color name is printed in incongruent ink colors; e.g. the word *red* might be printed in green ink. The participant is first asked to read each of the words on the page aloud, and then asked to name the *ink color* of each

word on the page. The challenge of this task is to avoid the initial impulse to read the words rather than name the ink colors. In this study, a participant's score was the number of ink colors named correctly on first attempt.

In Category Matching (CM), the participant is presented with a sheet containing 84 pairs of icons (Schwartz, 1994; adapted from Melnyk & Das, 1992). The participant evaluates pairs of icons, attempting to circle only those pairs in which the two icons belong to the same conceptual category. Twenty-one of the pairs are target pairs, while the remaining 63 are distractor pairs. The challenge of this task is in resisting the impulse to circle pairs in which the icons are similar in form but not in conceptual category. A participant's score was the number of pairs evaluated in 30 s less any errors.

We created a summary index of inhibition of initial impulses by averaging the *z*-scores of MFF (reverse-scored), Stroop, and CM.

Delay of gratification. A version of Rodriguez *et al.*, (1989) task was used to assess children's capacity to delay gratification. In this task, the challenge is to resist an immediate, smaller reward in favor of a delayed but larger reward. The participant is first asked which of two kinds of candy they prefer. Then, they are shown a very large and a very small bag of their preferred candy, and told that if they can wait long enough, they can have the larger bag; otherwise, they will receive the smaller bag. The test administrator then instructs the child to wait quietly with their eyes closed and leaves the room, taking the candy with her (*cf.* Rodriguez *et al.*, 1989). Scores on this task were the total time waited, with a maximum score of 15 min.

Results

Results are presented in four parts. We begin by presenting preliminary analyses suggesting that the relationship between near-home nature and self-discipline should be examined separately by gender. We then examine relationships between near-home nature and self-discipline for girls and boys. Finally, we address the potential role of age differences in the relationship between nature and self-discipline.

Preliminary analyses: should girls and boys be analyzed separately?

Previous research has hinted at gender differences in the effects of near-home nature on children (Faber Taylor *et al.*, 2001). To determine whether the effects of near-home nature on self-discipline would best be analysed separately for girls versus boys, we conducted a number of preliminary analyses.

First, we used independent *t*-tests to examine gender differences in self-discipline. Did the girls and boys in this study differ in their performance on the three forms of self-discipline? As Table 1 shows, there are gender differences on each of the three forms of self-discipline tested, with girls outperforming boys on two forms and boys outperforming girls on the third. Girls' scores are significantly higher on concentration and marginally significantly higher on impulse inhibition ($p=0.08$); boys' scores are significantly higher on delay of gratification.

These findings suggest that it would be prudent to take gender into account in testing for links between nature and self-discipline. To do so, we conducted 2×2 factorial ANOVAs examining the

TABLE 1
Means, standard deviations, and mean comparisons between girls and boys on measures of self-discipline

	Means		Standard Deviations		<i>t</i>	<i>p</i>
	Girls [¶]	Boys ^{**}	Girls	Boys		
Concentrating*	0.15	-0.12	0.58	0.52	3.24	<0.01
Inhibiting impulses [†]	0.09	-0.09	0.69	0.62	1.79	0.08
Delay of gratification [‡]	358	454	309	325	-1.95	0.05
Self discipline [§]	0.03	-0.02	0.53	0.48	0.65	ns

*Concentration summary=average of *z*-scores on four constituent measures

[†]Inhibition of impulses summary=average of *z*-scores on 3 constituent measures

[‡]Delay of gratification scores=total time waited in seconds

[§]Self-discipline summary=average of three *z*-scores: concentration summary, inhibition summary, and delay of gratification.

[¶]*n*=78

^{**}*n*=91

effects of gender and nature on self-discipline. In particular, we were interested in whether any effects of nature might be moderated by gender. Indeed, consistent with previous research, gender by nature interactions emerged for each of the three forms of self-discipline. Findings indicated that girls differed from boys significantly in the effect of near-home nature on concentration, $F(1,165)=5.7$, $p<0.05$, and delay of gratification, $F(1, 165)=5.4$, $p<0.05$. Girls differed from boys marginally significantly in the effect of nature on impulse inhibition, $F(1,165)=3.6$, $p=0.06$.

Accordingly, we examined the relationships between near-home nature and each of the three forms of self-discipline separately for girls and for boys.

Near-home nature and self-discipline in girls

Concentration. If near-home nature enhances this form of self-discipline in girls, we might expect girls with greener views to perform better, overall, at Symbol Digit Modalities, Alphabet Backwards, Necker Cube Pattern Control, and Digit Span Backwards. We used a simple OLS regression to examine the relationship between parent-rated naturalness of apartment view and a summary index of these four measures of concentration.

Do girls with greener views perform better at tests of concentration? Yes. On average, the greener a girl's view from home, the better she concentrates. As Figure 2 shows, there is a strong positive linear relationship between naturalness of apartment view and girls' performance on the summary index of concentration, $F(1,76)=10.9$, $p<0.01$, and each of the constituent measures echo this pattern. For each

scale point difference in rated greenness of view (for example, from 0 'not at all' to 1 'a little'), performance increases by roughly a quarter of a standard deviation, $\beta=0.233$. Greenness of view explains approximately one-eighth of the variance in concentration scores, $R\text{-squared}=0.126$.

Inhibition of initial impulses. If near-home nature enhances this form of self-discipline in girls, we might expect girls with greener views from home to perform better, overall, at Matching Familiar Figures Test, Stroop Color-Word Test, and Category Matching. We used a simple OLS regression to examine the relationship between naturalness of apartment view and a summary index combining these three measures of impulse inhibition.

Do girls with greener views perform better at tests of impulse inhibition? Yes. On average, the greener a girl's view from home, the more effective she is at inhibiting impulses. As Figure 3 shows, there is a positive relationship between naturalness of view and girls' performance on the summary index of these three measures; and again, the constituent measures echo this pattern. Naturalness of apartment view significantly and positively predicts impulse inhibition, $F(1, 76)=3.8$, $p=0.05$. Greenness of view explains roughly 5% of the variance in impulse inhibition scores, $R\text{-squared}=0.048$, with a beta of 0.172.

Delay of gratification. If near-home nature enhances this form of self-discipline in girls, we might expect girls with greener views from home to perform better on the Mischel delay of gratification task.

Are girls with greener views more able to resist the temptation of an immediate-but-smaller reward?

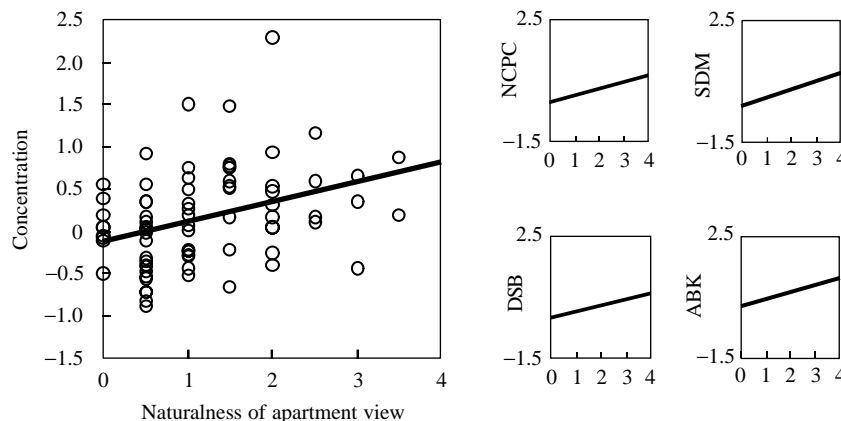


FIGURE 2. OLS regression of naturalness of view on the summary measure of girls' concentration (left) and its four constituent measures. All scores are standardized.

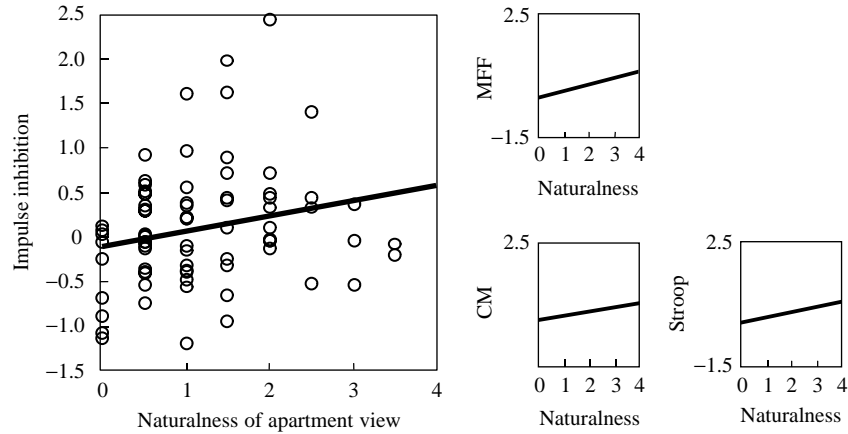


FIGURE 3. OLS regression of naturalness of view on the summary measure of girls' impulse inhibition (left) and its three constituent measures. All scores are standardized.

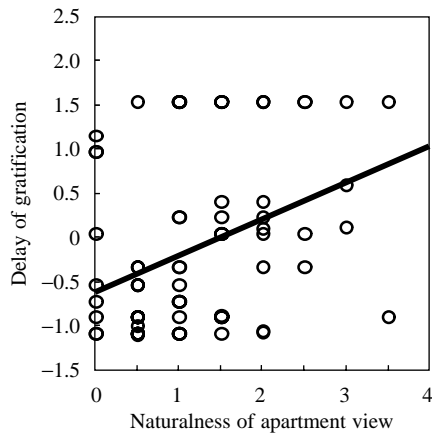


FIGURE 4. OLS regression of naturalness of view on girls' delay of gratification. Delay of gratification scores are standardized.

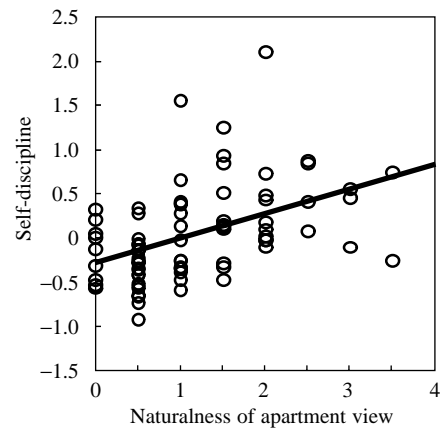


FIGURE 5. OLS regression of naturalness of view on the summary measure of girls' self-discipline. Self-discipline scores are standardized.

Yes. On average, the greener a girl's view from home, the longer she is able to delay gratification. As Figure 4 shows, there is a strong positive relationship between naturalness of view and performance on this task. Naturalness of apartment view significantly and positively predicts delay of gratification, $F(1, 76) = 12.7$, $p < 0.001$. For each point difference in rated greenness of view (for example, from 0 'not at all' to 1 'a little'), performance increases by almost half of a standard deviation, $\beta = 0.417$. Greenness of view explains roughly one-seventh of the variance in impulse inhibition scores, $R\text{-squared} = 0.143$.

Combined self-discipline measure. To further test the relationship between near-home nature and girls' self-discipline, we created a single index combining scores on the three forms of self-discipline. Do girls

with greener views perform better, overall, on these three forms of self-discipline? Yes. As Figure 5 shows, view from home strongly and positively predicts girls' scores on this combined measure, $F(1, 76) = 19.4$, $p < 0.0001$. On average, the greener a girl's view from home, the better she scores overall on different forms of self-discipline; for each point difference in greenness of view, scores increase by roughly a quarter of a standard deviation, $\beta = 0.274$. Greenness of view explains roughly one-fifth of the variance in self-discipline scores, $R\text{-squared} = 0.203$.

Near-home nature and self-discipline in boys

Table 2 summarizes the findings for the relationship between near-home nature and self-discipline by

gender. As a comparison between the left and right halves of the table shows, the findings for boys stand in startling contrast to the findings for girls. Whereas girls show consistent and often strong links between near-home nature and various forms of self-discipline, boys show only the barest hint of such a link. Beta coefficients for boys hover around zero for concentration, delay of gratification, and the combined self-discipline measure. For impulse inhibition, boys' scores show a slight tendency to increase with naturalness of the view from home, $\beta = 0.116$, but this relationship is not significant, $p = 0.13$.

Age, near-home nature, and self-discipline

To address the potential role of age in this study, we conducted 2×2 factorial ANOVAs (age \times nature) for concentration, impulse inhibition, and delay of gratification. Girls' scores and boys' scores were analysed separately. Findings for girls showed, not surprisingly, a main effect for nature view for each of the three forms of self-discipline. Girls' concentration showed a main effect of nature view, $F(1, 74) = 17.3$, $p < 0.0001$, as did girls' impulse inhibition, $F(1, 74) = 4.9$, $p < 0.05$ and girls' delay of gratification, $F(1, 74) = 8.6$, $p < 0.01$. There was no significant main effect for age, nor was there a significant interaction between age and nature for any of the three forms of self-discipline.

Findings for boys showed, again, no main effect for nature view for any of the three forms of self-discipline. There was a hint of a main effect of age on concentration, $F(1, 74) = 2.8$, $p = 0.10$, but there were no other significant effects for age on other forms of self-discipline, and no significant interactions between age and nature for any of the measures.

These results indicate that the basic findings of the study do not change when age is taken into account: for girls, near-home nature is consistently linked to self-discipline; for boys, near-home nature is not linked to self-discipline.

Discussion

This study tested for possible links between near-home nature and children's self-discipline, more specifically their capacities for concentration, impulse inhibition, and delay of gratification. Because preliminary analyses indicated gender differences — and, more importantly, interactions between gender and nature — for each of these three forms of self-discipline, we examined the relationship between nature and self-discipline separately for girls and boys.

For girls, views of near-home nature were systematically related to each of these three forms of self-discipline. Girls' performance on each of the following measures was significantly and positively related to nature: a summary measure of concentration (based on Symbol Digit Modalities, Alphabet Backwards, Necker Cube Pattern Control, and Digit Span Backwards); a summary measure of impulse inhibition (based on Matching Familiar Figures, Stroop Color-Word Test, and Category Matching); Mischel's delay of gratification measure; and an index combining the three forms of self-discipline. Differences in girls' near-home nature explained 20% of the variance in overall self-discipline scores.

Findings for boys stood in striking contrast to those for girls. Whereas girls showed significant, positive relationships between near-home nature and each of the outcome measures, boys showed no significant relationships between near-home nature and any of the outcomes. What might account for these gender differences?

One possibility seems promising at first, but becomes less plausible on further inspection — that nature restores directed attention in girls but not boys. First, there is no a priori theoretical reason to expect these effects to be limited to girls. Attention Restoration Theory (Kaplan & Kaplan, 1989; Kaplan, 1995) would suggest that nature supports directed attention in any individual with an intact attentional system. And consistent with this, the empirical work with adults suggests that the

TABLE 2
OLS regression summaries for naturalness of apartment view on measures of self-discipline for girls and boys.

	Girls (78)				Boys (91)			
	R^2	beta	F	p	R^2	beta	F	p
Concentrating	0.13	0.23	10.9	0.001	0.01	0.07	1.2	ns
Inhibiting impulses	0.05	0.17	3.8	0.05	0.01	0.12	2.3	0.13
Delay of gratification	0.14	0.42	12.7	<0.001	0.00	-0.03	0.6	ns
Self discipline	0.20	0.27	19.4	<0.0001	0.01	0.05	0.7	ns

nature-directed attention relationship is true for both males and females (Canin, 1991; Cimprich, 1990; Hartig *et al.*, 1991; Lohr *et al.*, 1996; Miles *et al.*, 1998; Ovitt, 1996; Tennessen & Cimprich, 1995). It is difficult to imagine why nature would affect directed attention in women, men, and girls, but not boys.

Another possible explanation for the lack of relationship between near-home nature and self-discipline in boys seems more promising. That is, perhaps boys are affected by contact with nature in just the way that girls are, but boys have relatively less contact than girls with the nature immediately outside their homes. Studies that have geographically mapped children's play have found that boys typically play farther from home than girls (Hart, 1979; Sobel, 1993); for reviews see Moore & Young, (1978), Wohlwill and Heft (1987). Perhaps boys are unaffected by near-home nature simply because they spend time elsewhere. Consistent with this, findings from a previous study indicated that boys' attentional functioning was not related to the level of nature immediately around their home, but was related to the level of nature in their usual play space (Faber Taylor *et al.*, 2001). Future research should examine the relationship between levels of nature in boys' most typical play spaces and their self-discipline.

The findings in boys notwithstanding, the overall pattern of findings in this study strongly suggests a link between near-home nature and concentration, impulse inhibition, and delay of gratification in girls.

Alternative interpretations

To what extent do the links between near-home nature and these forms of self-discipline reflect a causal relationship between nature and self-discipline? While definitively showing a cause and effect relationship requires a true experimental design, we can begin to address some possible alternative interpretations here.

One possible alternative interpretation for the current findings might be that self-discipline is linked to near-home nature, but not because nature enhances self-discipline. That is, perhaps some form of self-selection is operating: perhaps more effective, more self-disciplined parents find ways to be assigned to greener apartments, or they find ways to create greener surroundings, or the Chicago Housing Authority assigns 'better' prospective tenants to greener buildings. Chicago Housing Authority policies work against each of these possibilities. Apart-

ment assignment policies result in de facto random assignment of residents with respect to levels of nearby nature at RTH. Furthermore, on-going landscape maintenance at RTH is handled by a small landscaping crew; residents are not involved in maintenance and funds are inadequate to fulfill special requests from residents. Thus it seems unlikely that any of these forms of self-selection are taking place. Moreover, it is not clear why, if 'better' parents self-select into, or create, or are assigned to greener apartments, their superior qualities would be reflected only in their daughters.

Another possible interpretation might be that more self-disciplined children actually have the same levels of near-home nature as their less self-disciplined counterparts, and the link between self-discipline and high greenness ratings is an artifact. For example, perhaps more self-disciplined, more effective parents tend to have better lives and be in more positive moods than their less effective counterparts, and these positive moods lead them to be more agreeable, thus leading them to endorse items more highly – including their greenness ratings. Consistent with this, previous research has found links between mood and suggestibility (Tata & Gudjonsson, 1990). However, two considerations render this possibility implausible. First, the measure of naturalness of view in this study was composed of two items, one of which was reverse-scored. To the extent that positive moods induced residents of greener buildings to endorse all items more highly, the inflation in the reverse-scored item should balance the inflation of the positively scored item. And second, again, it is not clear how this explanation could account for the mothers of girls, but not boys, giving higher greenness ratings.

A third possible alternative interpretation might involve some form of experimenter demand. Might the interviewers have somehow influenced mothers with high-performing children to give greener ratings? Alternatively, might they have influenced children from greener buildings to score higher? Although these possibilities cannot be ruled out entirely, neither seems likely. The test administrators did not know the hypothesis of the study and thus would not know which mothers or children to influence, or in what direction to influence them. And yet again, it is not clear how this interpretation could account for the lack of relationship between nature and self-discipline for boys.

In sum, the links between nature and self-discipline found here do not appear to be simple artifacts of self-selection, systematic biases in assignment of participants to conditions, mood-

elevated nature ratings, or experimenter demand. Nonetheless, a causal relationship between nature and enhanced self-discipline — even for girls — remains to be substantiated.

Contributions to the literature

By documenting a systematic, positive link between near-home nature and three forms of self-discipline in girls, this work contributes to the research on the benefits of nature in three ways.

First, the results underscore the potential importance of views of nature. Previous research has shown that a variety of positive outcomes are associated with views of nature in adults in a variety of settings. In residential settings, views of nature have been linked to residential satisfaction, enhanced well-being, more effective patterns of coping, and greater day-to-day effectiveness (Kaplan, 1985, 2001; Kuo, 2001; Tennessen & Cimprich, 1995) respectively. In workplaces, views of nature have been linked to job satisfaction and well-being (Kaplan, 1993); in prisons, to decreased demand for health care services (Moore, 1981); and in hospitals, to faster recovery from surgery (Ulrich, 1984). The findings here add to a growing body of evidence suggesting that views of nature are no mere amenity.

Second, this work contributes to our understanding of the benefits of nature for children. Specifically, the findings from this study combine with the findings from a previous study to suggest that attentional restoration may be an important and universal benefit of nature for children. The current study links nature and superior attentional functioning in a sample of extremely low-income, attentionally normal African American children. The previous study linked nature and better attentional functioning in a primarily middle and upper-income, predominately European American sample of children with Attention Deficit Disorder (Faber Taylor *et al.*, 2001). Together, the two sets of findings suggest the possibility of a nature-attention link that generalizes across socioeconomic status, race, and attentional status, as well as different levels of residential greenness — from the most barren of public housing grounds to the lushest of backyards in wealthy neighborhoods.

Perhaps the most important contribution of this work is to identify two new benefits of nature. Previous research on a nature-directed attention relationship has focused primarily on cognitive outcomes, especially the capacity to pay attention or concentrate. Although previous findings linking nature and reduced aggression are certainly consis-

tent with the hypothesis that nature enhances self-discipline (Kuo & Sullivan, 2001b), to our knowledge, this is the first study to systematically document a link between nature and less cognitive forms of self-discipline, specifically impulse inhibition and delay of gratification. Failure to inhibit impulses can have both immediate consequences and important long-term implications for an individual; similarly, a pattern of failure in the delay of gratification may substantially alter the course of an individual's life and their chances of success in a variety of domains. For example, previous research has indicated that children's ability to delay gratification predicts their academic achievement, social competency, and ability to cope with frustration and stress in adolescence (Mischel *et al.*, 1988). If near-home nature can provide a daily, easily accessible means of supporting impulse inhibition and delay of gratification in a setting where individuals are likely to be chronically mentally fatigued (Kuo, 1992), the implications for individuals, families, and society may be enormous.

This study underscores the potential importance of views of nature, extends previous research on attentional restoration in children to a very different population and setting, and introduces two potential new benefits of nature: enhanced impulse inhibition and delay of gratification. The findings have a number of implications for practice.

Implications for practice

These findings help reinforce the importance of incorporating trees and grass in spaces for children. One implication of this research concerns the design of public housing developments. As a large proportion of urban public housing residents are children (in Chicago family housing in 1995, for example, roughly 60% of residents were 19 years old or younger; roughly 50% were 14 or younger, CHA, 1995), these findings argue for the potential importance of incorporating trees and grass around public housing apartment buildings. Moreover, these findings suggest that designers of public housing should consider more than just ground-level views of common spaces when placing trees and grass; it may be helpful to place trees and grass strategically within view from the surrounding apartments. Along the same lines, the findings here suggest that, in suburban areas and on the urban-rural fringe, the practice of constructing treeless residential developments may have important unintended costs. Previous work has suggested that the urban forest may be a vital part of children's

living environments (Faber Taylor *et al.*, 2001; Faber Taylor *et al.*, 1998); the work here reinforces that notion.

Another implication of this research concerns the design of schoolyards. These findings raise the possibility that incorporating trees and grass in schoolyards could play an important role in the classroom. Perhaps after spending breaks in green schoolyards, children return to their classrooms better prepared to pay attention, to suppress disruptive impulses, and to wait patiently for future breaks. Again, strategic placement may be important here. It may be that an occasional long glance out a classroom window helps support a child's capacity for self-discipline throughout the school day. Perhaps greater benefits from a given investment in landscaping can be obtained by placing vegetation to maximize views of trees and grass through classroom windows.

We close by noting the implications of this study for helping inner city children negotiate the many risks of urban poverty. The findings here suggest that the barrenness of inner city neighborhoods may contribute to lower levels of self-discipline and, potentially, to higher rates of negative outcomes in inner city children. In this study, the greener a girl's view from home, the better her performance on measures of concentration, inhibition of impulses, and delay of gratification. These three forms of self-discipline may play key roles in the likelihood of such negative outcomes as academic underachievement, juvenile delinquency, and teenage pregnancy. Perhaps when housing managers and city officials decide to cut budgets for landscaping in inner city areas, they deprive children of more than just an attractive view. Neglecting landscaping may deprive inner city children of a much needed resource for self-discipline – for the psychological capacities that lead to a brighter future.

Notes

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¹'Inhibiting initial impulses' has also been labeled 'inhibiting prepotent responses' (Logan *et al.*, 1997).

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